Electrical World

Published by McGraw-Hill Publishing Company, Inc.
W. H. ONKEN, JR.
Editor

VOLUME 87 — *New York, Saturday, May 8, 1926* — NUMBER 19

Commercial Developments Hold the Stage

WITHIN ten days the leaders in the electric light and power industry will assemble at Atlantic City, N. J., to tell of their accomplishments and out of that narration to take courage for the future. It would be difficult to match the record of progress which has crowned the efforts of the power companies during the past few years. And yet, great as have been their achievements, greater opportunities lie ahead. With the stupendous growth of our material wealth as a nation have come higher standards of living in which electricity has taken a prominent place. So much, in fact, have the electric light and power companies contributed to this advance that they are today intrenched in the hearts of the American public and enjoy a confidence unsurpassed in the industrial history of the nation. Measured by performance this faith is well deserved, and since the prime concern of the power companies of the country is to render the best possible electric service at the lowest possible rate, the proceedings at Atlantic City are of national interest.

COMMERCIAL developments focus all rays of the light and power industry because they are synonymous with electric service and contact with customers. Any successful business must give good service and maintain pleasant relations with its patrons; financial, engineering and operating elements are, indeed, measured in economic value by the yardstick of commercial accomplishment.

The light and power industry is interested in business development for many reasons, but they all can be included in the fundamentals of economics and public relations. The industry now has a very large investment in property and men, and it realizes that the time will soon come when it will experience a slackening in the increase of the business due to the addition of new customers. Facilities for greatly extending and augmenting its service have been provided with a minimum of expenditure, and without doubt the future will call for intensive commercial developments if prosperous conditions are to continue. From a strictly dollars-and-cents standpoint it is reasonable for utility executives to give attention to means for developing industry revenues, because greater revenue means better earnings and no sane business man hesitates to develop his market, particularly when it is far from saturation.

VERY potent reasons involving public relations call for more initiative and greater activity in commercial affairs. The light and power industry has been a fine public servant in the past. It has bettered its service and lowered its rates in the face of universal cost increases. Voluntarily it has made economies and extended its lines to serve new customers. But no public utility can stand still. It must go on and do a better and better job if it expects to retain the favor of the public it serves. In the future, as in the past, the goal must be still better service at still lower cost. This can be achieved through external commercial developments and internal operating improvements. Commercial efforts are necessary because the time has arrived when the industry must actually sell its service and not merely supply the minimum demand of the customers. It is necessary to intensify the use of electricity and to introduce new devices and appliances to the public. Followed through, such a program will result in greater revenues and more prosperous conditions for the utility and result in lower costs and greater service value to the customers.

Leaders of the light and power industry have always been alert and responsive to changed industry conditions. They have established a reputation for anticipating the future. Thus the coming convention, with commercial topics featured, indicates that executives in the industry are marshaling their forces again in ample time to do the commercial job necessary to stabilize the economic and public relations structure they have built.

The Nation Only 10 per Cent Electrified —Why Not Get This Business Now?

CONSERVATIVE analysis of undeveloped business shows that the present utilization of electric service is barely 10 per cent of what it might be if all the economically practical applications of electrical energy were served from the lines of the power companies in the United States. More than six times the number of kilowatt-hours would be sold than were sold in 1925, and the central-station companies' gross income would be increased to more than seven billion dollars—five times what it was last year. Truly, it is a bright future for every utility executive, employee and stockholder to contemplate.

Even then the market for electric service would not be 100 per cent sold as new means of utilizing electricity are continually advancing this mythical saturation point. What this huge undeveloped market does bring out is the need for a new viewpoint—a different philosophy—in the sale of electric service. The electrical industry is not so young. Much electrical equipment, both industrial and domestic, is being renewed or replaced because it is worn out, and still 90 per cent of the national market remains virtually dormant and undisturbed. The whole electrical industry is confining itself to a field one-tenth the size of the one it might enjoy.

Commercial activities of light and power companies have never attained a magnitude either in personnel or equipment proportionate to the other principal departments of an operating company. If existing markets are to be adequately developed, the sales departments must have the tools to work with. They must have more man power, more executive direction and more sales psychology. As much attention should be given and as much money spent from now on for sales development work as has in the past been given and spent for operating economies and engineering development. Rates and available markets are not bars to the enormous developments visualized in the analysis presented in this issue. The business can be obtained under existing conditions if the industry awakes and approaches the task from the viewpoint of the user of the service. It is only a question of how fast and how far the industry is willing to go to get the business that it ought to have.

Opportunities for Station Development and Improvement

NOT long ago many of the relatively new applications which are now being embodied in generating plants were looked at askance. If the experiences with some of these stations which are related elsewhere in this issue are any criterion, it appears that very satisfactory performance is being obtained with the new applications in these specific installations. While some problems still need to be worked out, progress made so far gives promise of their early solution.

Among the opportunities which have been suggested by operators of these companies for further developments and improvements are: (1) Furnace-wall construction that will permit higher rates of heat absorption without damage; (2) development of metals which will withstand more than 750 deg. F. at pressures up to 1,200 pounds; (3) improvements in methods of precipitating suspended matter in flue gases; (4) economic studies of desirable number of bleeder stages to use, taking into account cost, complications and attention; (5) providing a spare generator (not turbine and condenser) that can be substituted for a faulty unit to reduce outage of complementary equipment; (6) economic study of direct firing compared with central pulverizer systems, including unit investment, adequate reserve, attendance, noise and size of boiler bins; (7) facilitating the cleaning of furnace walls, tubes, air preheater, economizers while in operation; (8) cutting down the size of boiler coal bins by installing rugged coal-conveyor equipment which can be repaired within eight hours, and (9) preventing zones of high CO_2 in combustion chambers.

In addition, there are some suggestions which apply more particularly to powdered-fuel combustion, such as reducing the unit energy consumption for pulverization, minimizing mill noise, facilitating replacement of worn parts in mills, development of larger mills which will give as reliable service as the 6-ton mills now used, reduction of exhauster-fan erosion and abrasion of piping between mills and cyclone heads, improvements in powdered-fuel valves, means of agitating powdered fuel to prevent arching or packing, development of adjustable-speed arrangements for coal feeders so that group drive can be used, burner arrangements that will reduce the flame length, methods whereby complete combustion can be obtained with smaller combustion chambers, and further investigation of turbulent combustion.

Regarding stokers, suggestions have been made that means be developed whereby they will have more uniform efficiency over a wider range of load and the ability to force fires faster.

The Old Order Changeth in Central-Station Domestic Selling

THE electric light and power industry faces a dramatic situation. For forty years it has grown by accretion. Each central-station company in each community has expanded year by year by the simple process of adding more customers—new consumers connected to the distribution lines. And now the time has come when this is going to stop and expansion must be sought in a new way. It is generally recognized that the home offers the great market for load development in the immediate future, but it is not generally appreciated that this load cannot much longer be developed in the accustomed manner.

In the forty years of its activity the power industry has accumulaed 14,500,000 residence customers. For the last few years these homes have been coming on the line at the rate of from one million to nearly two million annually. The high point was reached in 1924, when 1,783,000 houses were wired. That was the peak of house wiring. Last year there were somewhere between half a million and a million. The reason is that a very high degree of saturation in house wiring has been reached. There are only 2,600,000 more houses waiting unwired within the reach of power lines. Therefore house wiring can be expected to dwindle from now on until it simmers down to the natural level of population increase, which will provide about 200,000 accessible new houses a year. Very soon, therefore, the central station will find itself unable to expand further by taking on more and more residence customers. The old order of market development must change. If systems are to continue to be extended, if the volume of the

business is to go on growing, if the popularity of light and power securities is to be unchecked and their value unimpaired, the electric light and power industry must turn from growth by gaining more customers to growth by building up the load of existing customers.

No man need be discouraged at this prospect, however. It is a fair statement that the domestic market for electrical energy stands but 7 per cent developed. About 94 per cent of these homes are without servants and need clothes washers, ironers, dishwashers, kitchen motors, refrigerators, electric ranges and the other labor savers that the central-station company has to offer. About 71 per cent of these homes are using electric flatirons. About 31 per cent have vacuum cleaners. About 21 per cent have clothes washers. But the other appliances show figures pitifully small. The industry has not yet begun to develop the home. The average annual consumption in the home is little over 300 kw.-hr. Yet there are enough domestic installations that use 1,200, 1,500, 2,500 and even 4,500 kw.-hr. a year to point the way with plenty of promise.

Here is the next big job for the light and power industry. It can be done. It will be done. But first must come an entirely new philosophy toward selling. It will require sales management of the highest order. It will require rate structures that are conceived more in the spirit of promotion than of mere protection. It will entail courageous investment and expenditure both for pioneering and for personnel. And as the force of the changing time is felt more amply these conditions will be met.

Engineering and Commercial Activities

MORE and better engineering talent as well as commercial talent is called for by the selling job before the light and power industry. The engineers and their works make the backbone of the whole utility structure, and the place of the engineer is at the top in the commercial as well as in the construction era. He must continue to build and to improve and attain the economies possible through greater production, large-scale utilization of electricity by each class of service and co-ordinated system operations. He must become versed in major-scale economics to do this, and yet he must continue his development of technique.

Intensified use of service calls for a universal generating, transmitting and distributing system. It calls for standard utilization equipments and the development of new equipments. It calls for technical developments in power stations, transmission, distribution, metering and utilization. Gains in dollars must be made through large-scale operations and through the development of better technical equipments, and this field is within the scope of the engineer. But there are other engineering elements. Service standards must be 100 per cent as regards reliability and quality, and these cannot now be obtained except at very high cost. Full interconnection of systems is called for if entire reliance is to be placed upon transmission lines, and there is much to be done in this field. Even in selling work there is so much technical background to successful commercial effort that the engineer is a vital factor.

As an executive leader in the new commercial era the engineer possesses very valuable qualities, and the industry will be better and stronger in the degree that the engineers become commercially minded and broadly executive in their attitude. They have a wonderful opportunity, and the industry has faith in their ability to meet the situation with the same competency they have displayed in meeting the industry's problems of the past.

Reliability of Transmission Lines

THE reliability of transmission lines seems to depend largely on the amount of money a utility company is able to invest in the line installation and the effort made to maintain the line and operating conditions at maximum efficiency. Investments in transmission lines must be made on the basis of economic studies of costs and returns, but there are so many factors to be weighed that a decision based on facts is difficult to make. Service interruptions mean a direct loss in revenue and an intangible loss in public relations. Yet even when the tangible and intangible values are weighed it is often uneconomical to install a line for 100 per cent service. The difference in cost between a line good for 99 per cent service and one built for 100 per cent service is often very great.

But once the economics of a situation are determined there are few engineering construction details which cannot be determined accurately. Lightning and surges are no longer unknown elements which afford splendid excuses for bad engineering. Insulators are standard in good performance if properly installed and inspected. The difficulties associated with structural-steel towers have succumbed to the skill of technical designers. Therefore any utility can build a line which represents the best return for the money spent.

But after a line is built its service value depends on good inspection and maintenance. Many companies fail to keep good inspection and maintenance records on lines, and this is surely bad practice, for all utilities hope to give the 100 per cent service at some future time when economic conditions warrant. Records are indispensable to such a plan. Some companies do not even apply a systematic inspection and maintenance program to their lines.

But beyond the installation and maintenance of lines there are some fundamental engineering problems to be solved. A study of the systems presented in the article in this issue shows a very wide divergence of opinion on the functional operation of a line as part of a system. Some properties use a solidly linked system of lines under all conditions; some go to the other extreme and remove all possible lines from service when a storm approaches or when trouble arises. Still other differences are found in relaying, in the method of insuring double feed to service points, in methods for getting selectivity in the event of trouble and in many other details. It is difficult to reconcile all the practices with fundamental principles, and there seems to be ample opportunity for engineering study. It is equally difficult to draw any conclusions from the data and experiences recorded, because local conditions and operating practices differ so greatly.

The fundamental approach to transmission development is a system study from a service standpoint. Each utility should plan to give an ultimate 100 per cent service to each customer, and the system should be developed with this goal in view. If this is done, money will be saved and principles will be established whereby each line on the system will have a functional position instead of being one of many self-contained structural units. Service continuity and system economics are the governing factors in transmission.

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The Residence Market Offers the Greatest Opportunity for Commercial Development

National Leaders on Industry Topics

Legislators, Public Utility Executives, Bankers, Railroad Presidents and Business Leaders Survey Conditions in Industry with Reference to Developments in the Light and Power Utilities — Interviews and Statements Replete with Thoughtful Comment

WITH the convention of the National Electric Light Association there comes every year the opportunity for industry-wide discussion of work accomplished in the preceding twelve months and for organized planning to give still better electric service to the nation in the year to come. To aid in these plans and in this work the ELECTRICAL WORLD has asked leaders of the electrical industry to give their views on particularly vital problems that confront the fraternity. In addition are included the views of leaders of industry not directly connected with any branch of the electrical business who kindly consented to talk about aspects of light and power from the angle of outside observation and less intimate concern with internal affairs. A study of all these appraisals and points of view will conduce on the one hand to pride in accomplishment and on the other to a determination to attack with renewed zeal, thoroughness and thoughtful intelligence the vast task that remains to be done before complete electric service prevails in this country.

The Coming Household Load

BY JAMES E. DAVIDSON
President National Electric Light Association

IT MUST be apparent to executives in the electric light and power industry that the time is approaching, if it is not already at hand, when more intensive development of existing customers will be necessary. Thus far the industry by means of huge generating stations, interconnections, cheaper financing and other economies has succeeded in holding down and in many cases reducing the cost of electric service in the face of rising prices for all that enters into that service; but this process cannot go on indefinitely. Generating stations cost considerably more now than they did ten years ago, servicing costs more, and despite the resourcefulness and skill of our engineers and the watchfulness of executives in taking advantage of favorable money market conditions, it will be difficult to maintain the gains already made unless we can increase the income per service.

JAMES E. DAVIDSON

What we have so far achieved is remarkable. It is a wonderful tribute to the skill and enterprise of the industry. To be able to render service to the ultimate consumer at a cost to him 8 per cent less than before the war, or, taking into account the depreciated value of the dollar, at a rate approximately 14 per cent less, is an accomplishment in which the industry can take pride. And yet it is possible to soar to greater heights of accomplishment and increase the usefulness of electric service to the householder and the community by giving thought to commercial possibilities now dormant. Street lighting, for example, is twenty years behind the times. With few exceptions most of our cities are still shrouded in darkness notwithstanding the excellent load-factor characteristics of the business, the advantages and cheapness to the city of well-lighted thoroughfares and the general upward urge it imparts to window lighting.

The greatest opportunity before the industry, however, outside of the complete electrification of the railroads and other basic industries now only partially electrified, lies in the home. Householders make up the bulk of our customers, and that business as a whole has been the most neglected. We sell the householder a service of inestimable value, all the advantages of which he does not obtain or even appreciate, because the electric light and power companies have not properly sold the service or encouraged the householder to use more of it. Millions of homes are inadequately and improperly lighted, and many more have yet to experience the comforts and conveniences of labor-saving appliances. Educated to the values of electricity and to its cheapness compared with other items in the family budget, every home would consume many times more electricity than it does at present, and the householder, in view of the great convenience and excellence of the service, would be less inclined to question its cost; because on a proper rate base the cost would not be exorbitant. Moreover, the diversity and load-factor characteristics of the household load when properly developed are excellent, and the business when built up is profitable. The load from all angles, therefore, is greatly to be desired and offers to electric light and power companies the opportunity to render greater service and to the householder the hope of still lower rates. To me this outlook is exceedingly promising and I see in it unlimited opportunities for a greater, stronger and richer industry.

What Electricity Has Done for North Carolina

BY ANGUS W. MCLEAN
Governor of North Carolina

IN THE industrial development in North Carolina—a state only recently described as one which has cleared "with one bound the morass of fifty years of poverty and depression to reach the level plane of a new century of promise and achievement"—electrical energy has had a major part. A little more than two decades ago there was not in the entire state a single electric light plant in the modern sense. Today there is a conservatively estimated total hydro-electric power installation of 600,000 hp. on North Carolina streams. The output of electrical energy totals 1,500,000,000 kw.-hr. a year. At present electric power and light utilities have installed in this state 433,711 hp. and in addition deliver the output of 411,300 hp. installed in other states carrying this 845,000 hp. over 2,000 miles of high-tension transmission lines.

HON. ANGUS W. MCLEAN

What the release of this store of clean, economical and reliable power has meant to North Carolina is reflected in what North Carolina industry has achieved. More than 500 textile mills give employment to 90,000 persons and manufacture products with a yearly value of $400,000,000. Great factories, the largest in the world, make North Carolina the premier state in the manufacture of tobacco, the products of which have a value upward of $300,000,000 annually. Several of our towns, notably the city of High Point, are centers of a furniture industry important in the nation, the value of whose products is in excess of $50,000,000 annually.

In 1923, according to official figures of the United States Department of Commerce, the total value of our manufactured products was $951,911,000. Today that figure exceeds $1,000,000,000. Electric power has freed our industry for expansion. Incomparably has it helped to raise the standard of desire out of which the standard of living is born.

In dealing with this great new industry, which has so wisely and with so little friction recognized the necessity for governmental regulation, the State of North Carolina has been and will continue to be helpful and liberal in policy. We do not coddle corporations, but, what is more important, we do not bait them. If the state is to continue its wonderful industrial expansion, if it is to make the best use, through allied industry and manufacture, of its rich mineral resources, if it is eventually to bring about economic practice on the farm, we all know that to these ends nothing will contribute more greatly than the corresponding expansion of our supply of electrical energy.

Pussyfooting with Government Ownership

BY JOHN B. MILLER
President Southern California Edison Company

THE time has come to stop pussyfooting on the question of government ownership. This does not apply particularly, perhaps not at all, to the men of the electrical industry. Those men have generally been outspoken and consistent. The application is to all those men of common sense—and they are many—who have been misled into passive acquiescence in various specific local schemes for government ownership based upon supposed local benefits. Plenty of business men who are opposed to government ownership in principle have nevertheless got behind some local scheme without realizing that it is in the nature of fire to burn. There have even been men in our own industry who have at times looked with friendly eyes at some disguised government-ownership scheme that did not directly affect them. Why is this? Isn't it because we have been pussyfooting on the fundamentals?

The plain truth should be told. Advocates of government ownership, whether they know it or not, are enemies of society. If some cult of faddists tried to bring yellow fever back to the communities it once ravaged, it would get short shrift. It wouldn't matter if the faddists sincerely believed they were doing good. You can get a sincere lot of cracked-pots to advocate anything at all. Sincerity alone means nothing. Why shouldn't we tell the real story? There is no doubt about the truth of that story.

Government ownership has been tried ever since there were governments. It is an old and discarded policy. Government ownership built the pyramids of Egypt, but no one claims that Egypt's form of government was either democratic or desirable. Government ownership brought a dictator to Italy; they were so deep in the mire that a dictatorship was the only way out. Germany, not quite so badly off, turned its railways over to a corporation in order to change deficits into net revenues. The current economic bulletin of the National City Bank comments on the heavy deficits of the state-owned Belgian and French railroads and points out that although the stabilization of those countries seems to demand the unloading of their railway burdens, the political strength of the bureaucratic systems is a stumbling block. A similar situation exists in a part of Canada, where, as Professor Mavor has demonstrated, a government-ownership oligarchy has become the government. Our own experiences with government railroad operation and with government shipping are well known. Out of all of the experiments, from

JOHN B. MILLER

Pharaoh to Pinchot, there is not a single known instance where government ownership — national, state, municipal or other—has been beneficial. It is known that the system cannot continue in a democracy. Either the democracy or the system must go. The evidence is complete. We need no more experiments.

Let us tell the plain facts. The system is wicked; its advocates are enemies of society.

Business Outlook in the West

BY WIGGINTON E. CREED
President Pacific Gas & Electric Company

ELECTRIC UTILITIES of California enter 1926 under favorable auspices. Late rains have refreshed the mountain streams and added to the stored waters from which the state's great supply of hydro is produced, promising what the engineers call "a good hydro year." Equally important is the fact that the rains have freshened the earth, restored underground waters and filled the artificial reservoirs, thereby assuring an ample supply for irrigation during the summer months. In consequence agriculture, California's greatest industry, is facing a prosperous and productive year. Its prosperity will be reflected through all lines of activity, and with it will come a steady and increasing demand for electric energy.

The companies enter the year prepared for any demand that may come upon them. In fact, in northern California at least, the beginning of the year finds hydro capacity actually in advance of demand. However, the companies are not waiting for demand to overtake capacity, but are pressing on to new developments so that capacity may continue to keep in the lead. To that end new hydro plants of approximately 208,000 kw. and steam plants in excess of 100,000 kw. have been projected for 1926. All may not be completed within the year, but construction will move fast enough to close the year, as it began, with capacity in advance of the demand.

The year 1926 will see a continued expansion and extension of electric service in California. That is, service will be further spread out and intensified in territory already developed and be extended into new territory whenever opportunity affords. However, there is now little of populated territory in California that is wholly unserved. Opportunity to serve and duty to render service in 1926 will be in the older and settled rather than in the newer and undeveloped sections of the state.

Expansion of service will come by stimulating a greater use of existing facilities, by creating a wider demand for electric energy for lighting, cooking and heating and for appliances generally and by introducing electric energy into fields before served by other forms of power or energy.

It will probably take from 12 to 14 per cent more kilowatt-hours to supply this demand than in 1925. In 1925 the increase in kilowatt-hours used was 13 per cent over 1924, and for the first time in the history of California the state's kilowatt-hour output passed the six billion mark.

To the industry itself perhaps the outstanding event in 1926 will be the opening of the Harris J. Ryan Electrical Laboratory at Stanford University, the second in California. Here opportunity will be given for experiments that will no doubt soon lead to great changes and improvements in high-tension transmission. Dr. Ryan has said that the day is coming, perhaps within two decades, when we shall have a single huge electric power line extending from the Mexican border to the Canadian boundary, with "tap-ins" from local water powers and "tap-outs" to customers along the way. When that day or any other day of great transmission problems comes, the industry will be ready. Its problems will have been solved in advance through the experiments and studies of the great company of geniuses who are applying themselves to electrical problems in many sections of the country.

W. E. CREED

Railroad Electrification

BY RALPH BUDD
President Great Northern Railway Company

ANSWERS to the following questions that were submitted to Ralph Budd, president of the Great Northern Railway Company, bring out some facts and conditions regarding railroad electrification which must be appreciated by every one, from the general public to those most intimately concerned. Mr. Budd states his considered opinions on the future prospects for electrification, on the benefits to be derived therefrom and on the conditions that must be met. The questions and answers are presented verbatim:

Q. In what order will future railroad electrification occur most likely—in large terminals, along heavily traveled trunk lines, over mountain grades, etc? Where are the greatest possibilities geographically now?

A. On mountain grades where hydroelectric power is cheap; in terminals which can show large incidental advantages such as enhanced values of real estate; along heavily traveled trunk lines which are approaching the limit of their capacity on present trackage and where more right-of-way will be necessary; also in the eastern part of the country over mountain grades with heavy traffic, especially in coal, which gives uniform high load factor through the year.

Q. What facts must be obtained before such electrification is accepted by railroads?

A. There must be more data based on actual performance as to (a) cost of construction; (b) cost of operation; (c) savings due to electrical operation; (d) incidental advantages, such as enhanced values of real estate, increased efficiency outside of savings in operating cost of traction power.

Q. Are not the cost of electrifying and the difficulty of attracting the neccessary capital the obstacles to electrification more than any doubt regarding relative performance of steam and electric equipment?

A. I do not think so. Necessary capital is obtained by railways in large amounts where the saving to be made by the investment justifies it. It is not a question of relative performance of steam and electric equipment, but a question of savings that may be made in operating expenses by reason of electrical installation. Unless traffic is heavy or some of the other conditions in answer to Questions 1 and 2 obtain, it might not be prudent to invest large sums for electrification even though the funds were readily available.

Q. What can the electrical industry do directly or indirectly (through educating the public possibly) to enable railroads to shoulder the financial burden of electrification?

A. The public may be educated to appreciate its interest in having the railroads earn a fair return on the

value of their properties, so that they may be able to provide facilities for still better service. Open-mindedness on the part of the large electrical equipment companies as to the type of electrification best suited to each case, rather than always insisting upon a certain type of electrification, would tend to dispel the doubt created in the minds of railway men because of the conflict between the types as advocated by the manufacturers.

Q. In terminal electrification, is it not likely that the value of overbuilding rights made possible thereby will offset the cost of electrification?

A. This point was mentioned in Question No. 1. Circumstances in each case will govern. The New York Central electrification in New York is the outstanding example of the high value of overbuilding rights. In many terminals there would be no such appreciable added value.

Q. For trunk-line electrification, what is the maximum limit that fixed and operating charges for electrification can attain per ton-mile of traffic per year to warrant consideration by railroads? (Any other basis will suffice.)

A. Operating charges after electrification must be enough less than they were before electrification (or than they would be after other improved operating conditions that might be brought about) to pay interest on the excess cost of electrification and at least 5 per cent per annum additional as a factor of safety.

Q. Should railroads load themselves with the capital expenditure for generating plants, transmission lines and substations and further complicate their already complex problems by generating power, if power can be purchased at a reasonable figure?

A. The answer depends upon whether power can be generated by railroad-owned plants for less than it can be purchased from power companies. The power companies should be able to sell it more cheaply than railroads can make it, but if they are not willing to do so the railroads should not be restrained from making their own power. Such restraint might tend to higher prices, which in turn might discourage railway electrification.

Q. Based on past influences of transportation and electric power on the commercial and industrial growth of communities, is it not possible that trunk-line electrification would increase traffic because of the more reliable and cheaper electric power made available by transmission lines paralleling the railroads?

A. If transmission lines can be built along railroad right-of-way enough cheaper than elsewhere to justify making lower prices for electrical energy, undoubtedly industries would locate where the cheaper power is obtainable, but it does not seem reasonable or feasible to make a lower rate to industries supplied with power from transmission lines along railroad right-of-way than to other customers whose power is supplied by other transmission lines of a like character.

Rural Electrification a Farmer Problem

BY CHARLES L. EDGAR
President Edison Electric Illuminating Company of Boston

TO MY MIND, rural electrification is the most important unsolved problem in which the electric utility industry is concerned at the present time. Although there are, of course, many problems connected with our business that are not yet settled, most of them are in process in being settled, and those connected with the industry can see that headway is being made.

The only notable exception seems to me the broad question of rural electrification. Personally, I do not see the solution. I have a feeling that the problem is not a public

C. L. EDGAR

utility question so much as a farmer problem. When one realizes that the great majority of the farms in the United States are occupied by tenants, most of whom are short-term occupants, it will be seen that the ability to make improvements and expenditures looking to electric equipment is very largely lacking. The owners, mostly absentees, are not interested, and the tenants have little initiative or incentive to equip themselves electrically.

This is true of practically no other line of industry with which I am familiar. The public utilities may be entirely prepared to do their share, but this does not solve the problem if the other party in interest is not in a position to do his share. Here is a definite economic task for the special organizations and agencies working to improve the farmer's lot in life, and I am certain that the light and power industry will co-operate to any reasonable degree in seeking a solution of this perplexing problem.

Utility Security Situation

BY H. M. ADDINSELL
Harris, Forbes & Company

REALIZATION of the intrinsic soundness of the public utility industry as a whole, and particularly of the larger electric, gas and telephone companies, has in recent years become more and more universal. During 1925 the most spectacular indication of this popularity was, of course, the soaring prices for public utility common stocks. In many cases these prices were, to be sure, carried by the active bull market of last fall to levels that could hardly be justified by present earnings or immediate prospects, but although these earlier excesses have been corrected by the recessions of the past month or so, public utility common stocks are still selling at levels that indicate a general realization of the prospects and possibilities of the industry that did not exist even a few years ago.

Many other developments during the past year bear unmistakable evidence of the popularity of public utility securities. It is now customary to emphasize any public utility features in new financing. Large industrial concerns have found it more economical to finance supplemental power projects as independent public utilities than through the issue of their own securities. It has been possible to sell securities of coal-mining and other properties operated in conjunction with public utility companies on a more advantageous basis than would have been possible in the case of independent properties.

The holding company has been used largely as a medium for junior financing in the form of debentures or stocks. It has been generally recognized that this type of financing has resulted in substantial benefits to the operating companies and their customers as well as to the purchasers of such junior securities. In the recent issue of $65,000,000 Associated Electric Company convertible 5½ per cent gold bonds, the largest single piece of gas and electric company financing on record, this basic idea was made use of for senior financing purposes. Instead

of having the individual subsidiaries sell their own mortgage bonds for additions and for refunding their high rate securities, a single large issue was put out by a new holding company formed for the purpose. This issue was set up on the same conservative basis as the better grade operating company mortgage bonds. The aggregate funded debt of all the subsidiaries plus the new issue represented only a conservative proportion of the total property value, and consolidated net earnings were in excess of twice the aggregate annual charges.

Most significant of all has perhaps been the trend of the very conservative type of investor toward electric, gas and telephone mortgage bonds.

Insurance companies and other large institutions in a position to employ shrewd and experienced investment experts have, of course, been purchasing the better public utility bonds for many years. The investment powers of savings banks are carefully regulated by law in most states, and quite rightfully so in view of the trustee nature of their relations with their depositors. The laws of a dozen or more states have for some time specifically permitted the investment of savings banks' funds in utility bonds, and during 1925 definite legislative action has been taken in four of the most conservative Atlantic seaboard states to broaden the powers of savings banks for the investment in the highest grade public utility mortgage bonds. The bills brought forward in the Connecticut and New Jersey legislatures have been passed. The bill in Massachusetts is still under consideration and the prospects for its passage are considered good. The bill in New York State has had the backing of the State and National Savings Banks Association and passed the Assembly, but was not brought to a vote by the Senate before adjourning. It is expected that it will be brought up again at the next session of the Legislature.

The prospect of the passage of this bill was considered by many to be one of the important factors in the recent impressive strength in the market for high-grade public utility bonds. The action of the market during the last few days indicates, however, a much broader basis for the recent rise. A few of the issues that had been particularly active because of the expectation that they would qualify under the law have had slight recessions, but the tone of the market, as a whole, has been one of continuing strength.

Changed Conditions Confront Electrical Industry

BY PHILIP CABOT
Head of Department of Public Utility Management, Harvard Graduate School of Business Administration

IT SEEMS to me quite clear that the electrical industry, like most others, is confronted with conditions that have changed radically since the war. Before that time the companies' customers were largely domestic users and their operating income was practically panic-proof. Since the war the development of the power

PHILIP CABOT

load has been amazing, and the most recent figures I have seen indicate clearly that, as a result, the electric companies are now directly affected by the business cycle. They may not be so much affected as other industries, but the time is clearly ahead when they will be. As a result of this, during the next ten years their income will fluctuate with the rise and fall of general business activity. Some of the engineers hope, I think, that by the use of two-part rates with a skillfully designed demand charge they can be protected against a sharp reduction of income. This is open to question, because it flies squarely in the face of the recognized law of trade that prices cannot be raised in a period when trade is falling off. No other merchant can raise his prices in the face of falling customer demand. The two-part rate, of course, is designed to produce this result, but it remains to be seen whether it can be enforced. If it can be, it will be the only case that I know of where this has been successfully done.

The importance of this lies in the fact that in the past the companies have paid little or no attention to statistics dealing with the general rise and fall of trade activity, but if their business is affected by this cycle, as other businesses are, it is vital to them to see the trend in advance as other merchants attempt to do. The general tendency of the times seems to me to indicate that the most important function of management in the future will have to do with sales management. The engineers have done their part, and have done it very well, but the time when this can be regarded as the most important function of management has passed.

The Increasing Cost of Distribution

BY JOHN H. TRUMBULL
Governor of Connecticut and President Trumbull Electric Manufacturing Company, Plainville, Conn.

THE electrical industry's unique position in continuing to furnish service at a cost so low in proportion to the cost of other commodities cannot be maintained indefinitely unless the increasing cost of distribution is lessened.

The point is now reached by both manufacturers and utilities where the cost of producing has decreased until it is but a small portion of the total, whereas the cost of distribution has risen at a much faster rate.

Most of the difficulties in the electrical business have been met with success, the result being that every man, woman and child is not only a possible but probable user of electricity in an ever-increasing number of ways.

The demand for service, coupled with the satisfactory relations now enjoyed between customer and producer, has made easy and safe financing possible. This condition, in turn, stimulates the demand for equipment, apparatus and appliances, causing the outlook for the future to appear brighter than ever before.

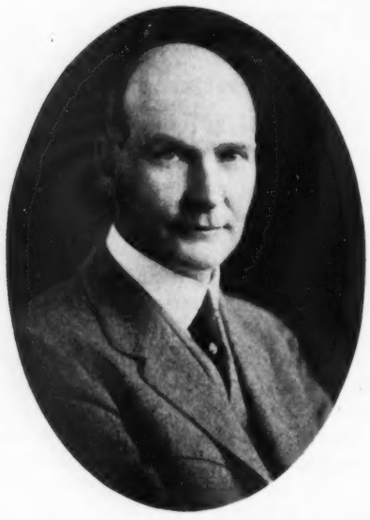
The peak has been reached, however, unless the rising cost curve of distribution is flattened out and ultimately made to recede. A greater number of customers and a larger per capita sale theoretically should

not increase the cost of delivery, but this is the situation.

The power companies are contrasted to the manufacturers in the tendency to form so-called superpower systems, a few centralized generating stations feeding exceedingly long transmission lines; whereas the manufacturer considers the advisability of establishing branches, in which the cost of producing may be somewhat more, but a tremendous saving in distribution is made possible.

The problem is common to both, the same answer is sought, and no doubt there is more than one solution. But whatever the method, a satisfactory result must be and will be found.

A standardized low unit cost of manufacture has been reached, but a standard unit cost of distribution



HON. JOHN H. TRUMBULL

has not yet been attained. It is not a simple matter, that might be settled by a lower freight rate or a higher transmission voltage, but an intricate question, capable of being settled not by the engineer alone, but by the united efforts of every man in the electrical business.

Neither will federal or state control help much, unless there is federal and state co-operation. Electric utilities are essentially private enterprises, experience having shown this conclusively, and only as such can they be of the greatest service.

The problems of the past have been solved by devotion to the art, fair-mindedness, square dealing, unselfishness and the genuine desire to serve that characterizes the electrical man. The present problems require the same treatment.

Public Regulation of Electric Light and Power Utilities

BY A. G. PATTERSON

President National Association of Railroad and Utility Commissioners and Alabama Public Service Commission

BILLIONS of dollars are already invested in the plants and systems of the electric light and power utilities of the United States and their growth is so rapid that the amount of money invested will be multiplied many times within the next few years. The people could not now dispense with the service rendered in furnishing to them light, heat and power by such utilities. The immensity of the investment and the necessity and importance of the service are such as to impose great responsibility upon every agency that affects the present and future of this investment and service.

Fortunately for everybody concerned, the development of these utilities came within a period when those investing in such properties and those charged with the operation thereof were prepared in mind to accept public regulation as a proper factor in the carrying on of such business and to co-operate with the agencies through which public regulation is effected. The electric utilities in this respect have been more fortunate than the railroads were, because the development of the railroads in the United States, in large measure, had taken place before the people asserted any substantial measure of regulation, and consequently within recent years there was an unavoidable clash when the people began to assert a substantial measure of public regulation of the railroads. The executives of the railroads practically had proceeded with their business as if it were a private business and it was difficult for them to accept, in mind or in fact, the principle of public regulation. Fortunately this attitude of mind on the part of the executives of the railroads is passing out.

Although there are and always will be differences of view as to the details of public regulation, it would seem that the basic elements are comparatively simple. In the first place, the utility plant must be wisely conceived and planned. The capitalization should be economical, clean and sound. The accounting methods should be clear, accurate and comprehensive enough to show the actual facts touching the capital expenditures and costs of operation. Security issues should be made upon a sound, economical basis. If the utility has been wisely planned and properly capitalized and is operated economically and efficiently, capital

A. G. PATTERSON

necessary for extensions ought to be able to be secured in large amounts through the issue of preferred stock rather than bonds. The desirability of financing in this way has been emphasized by recent expressions of the Interstate Commerce Commission. The operations of the utility should be honest, economical and efficient, and reasonable replacement reserves be provided. When any utility has been so planned, capitalized and operated, we believe the regulatory authorities will not hesitate to prescribe rates that will assure a reasonable return upon the investment.

The day is past when public service corporations may hope to prosper by undertaking in any way "to put something over" on the public. The principles that should govern fair value are being clarified and determined. Proper accounting methods will enable all persons affected to know with reasonable certainty whether the utility's operation is honest and economical. Test proves the efficiency of its service.

With intelligent, fair-minded co-operation between the utility and the regulatory authorities, the business of the electric utilities can be so conducted as practically to insure a fair return upon money so invested. As long as this is true, there will always be money at hand to provide extensions and greater development

of the business. Thus the perpetuation and growth of electric light and power utilities is assured and the people can go forward with the confident assurance not only that their present needs will be taken care of but that adequate provision will be made for the larger demands of the future.

Treat Customers as Partners

BY M. S. SLOAN

President Brooklyn Edison Company

BECAUSE public utilities are enabled to transact their business by grants of rights to use public property, and because they are almost always monopolies, the public feels and always will feel that it has a special claim on them such as it has on no other class of business. It considers them public servants like its elected officials and expects from them equally public-spirited standards and course of conduct. When it doesn't get these, or thinks it doesn't, it kicks, and much trouble results for the utilities.

I don't blame the public. Its feeling is rooted in the fundamental law which declares utilities to be "affected with a public interest," and it is justified. It is the utilities' inability or laxity in meeting this feeling man-fashion which constitutes our problem in public relations. In the electric light and power industry we are dealing with it progressively, but not comprehensively and completely; and I think the sooner we all get down to cases on it, the sooner it will disappear as a problem, as so many big technical and financial problems have disappeared.

The main thing to do, as I see it, is to stop thinking of the public as customers, as public officials, as newspaper editors and what not, and to begin thinking of them first as human beings who have a definite property interest in our companies —which they have. They are, in effect, partners in the business, and when we get that view of the situation we're going to be a lot less likely to carry a chip on our shoulder and a lot more likely to meet them in a spirit of fair play and desire to satisfy them.

The next thing, thinking of them as partners, is to treat them as partners. Let them know what this business of theirs and ours is doing. Let them know by all possible means of contact and information until there is no chance of misinformation or misunderstanding. Cultivate their friendship and confidence by all the methods employed among individuals, and do it in human, friendly fashion, because it's the right thing to do—not as advantage seeking or patting on the head. If what we're doing with the business is all it ought to be, let them know it and be as proud of it as we are. If it isn't, let them know how and why and win their help to make it better.

The next thing to do is to make this somebody's job—not just anybody's job, which means nobody's job. And if the company's chief executive doesn't make it his job, let him put all his vision and sincerity and backing behind whoever is handling the work. Then things will happen.

Our trouble is that we all talk a lot about improving our relations with the public, but in far too many cases take it out in talk. When we all *WORK* harder on this job—and there's no company too big or too good to need to work harder, and no company too small to be able to work on it—we'll get along a lot faster and get further toward possessing the friendship of the people, which we desire and need.

Greater Service Through Future Economies

BY SAMUEL FERGUSON

President Association of Edison Illuminating Companies and of the Hartford Electric Light Company

SAMUEL FERGUSON

AT THE present time of approximately stationary costs of labor and supplies, the executives of electric companies are noting with considerable surprise the extent to which their costs are decreased with increased volume of business. As a consequence of this they are beginning to realize what a terrible obstacle they successfully surmounted during the recent years of increasing costs.

This easier earning situation is reflected in the greater degree of service today being rendered to the public through extensions of facilities to less profitable territory, through increased reliability and through lower prices.

In spite of this there is in the air a fear on the part of the public that in the long run it will not equitably share in the benefits to be derived from the present trend toward interconnections and consolidations. It seems to me essential that some method be devised of assuring the public that its interest in obtaining its share in future economies is safeguarded and that the entire future benefit is not to be appropriated by the companies through the capitalization of all the prospective economies in sight.

In the sale of securities to the public the future earning power, as justifying the soundness of the issue, has been altogether too heavily stressed and no weight at all has been placed on the benefit to the companies to be derived from their ability to render a greater degree of service. This latter factor is the real protection to any issue of securities.

The Banker and the Utility

BY RICHARD E. NORTON

With W. H. Newbold's Son & Company, Philadelphia. Governor Investment Bankers' Association of America

ELECTRICAL WORLD has asked me to define the relationship between banker and electrical utility. As I see it this relationship is one of a triple trusteeship on the part of the investment banker. First, he is a trustee of the interests of the investor, which is the public; second, he is a trustee of the interests of the property, electric utility or other, in which the investment is made, and, third, he is a trustee of the interests of the community, for the reason that any increase in the wealth of a community is a direct contribution to the welfare of the investor and the property.

Naturally the relations existing between the electric light and power industry and the investment bankers of the country have always

been most cordial. Together they have brought about a development which, beginning in 1882, occupies today a commanding position among American activities. Requiring, as they now do, vast sums of money yearly to carry on their prodigious work, the electric public utilities normally look to the investment bankers to purchase and sell their senior and a part of their junior securities, and in this the investment bankers are glad to be of service. It is appropriate that in this age of specialization the electric utility recognize the service which the investment banker renders in his field, while the investment banker recognize the service which the utility executive renders in his.

Looking to the future, the investment bankers of America view with the greatest interest the continued physical development of the electric utility industry in the United States. The bankers are not unaware of what economic advance is brought about by interconnection, by hydro-electric development and by still greater efficiencies of steam-electric generation. The bankers are sympathetic always to the enlightened position which the utility managements recognize as just and desirable, in passing on to the public, through rate reductions, the economies which their genius and persistence have secured. Nor is the investing public utterly oblivious of these achievements, because public utility securities are very popular on the market, and therein lies an element of danger. Public utility executives and investment bankers both recognize the necessity of safety and ready marketability for securities.

Stability of management, a firm and just policy, public relations in the true sense, business ethics of the highest order — these are the safeguards alike to investor, to utility and to the community. As I view the situation, the electric utilities, with their background of more than 40 years of progressive achievement, have ahead of them an era of ever greater service in American life, industry and business. Moreover, in my opinion your industry should have little difficulty in securing the necessary funds for proper development, provided the securities are adequately safeguarded and the industry polices itself to the extent that none but the best securities are offered to the public.

Public Relations Still the Most Important Industry Problem

BY EDWIN A. BARROWS
President Narragansett Electric Lighting Company, Providence, R. I.

A BETTER understanding of the utility industry by the public remains the most vital of all the issues with which the central-station world is at present confronted. We need not belittle the progress of the past in this great task of winning the public to a comprehending friendship for our ideals and for the men and women who are part of the electrical industry.

The prosperity of the central stations has aroused jealousy in some industrial circles and unthinking criticism in quarters that ought to know the truth. Without prosperity, our service must fail to meet acceptance and capital for its enlargement and extension cannot be obtained. Our industry does not enjoy profits in the usual sense; it simply receives a reasonable return and no more upon the total cost of its service, and the tendency is practically irresistible for that cost to diminish per unit as engineering science advances and as good management and excellent public relations work together to build up the community welfare. In both domestic and industrial budgets the cost of electricity is relatively so small a proportion of the total that it is difficult to understand why any one cares to waste time attacking rates unless for some political or ulterior purpose.

EDWIN A. BARROWS

Public relations are constantly improving as utility men and women visualize their importance and practice good will and courtesy. Every reason exists for encouragement, but to assume that the task is done would be to put the entire industry in peril.

The Sleeping Giant

BY T. O. KENNEDY
Vice-President and General Manager Ohio Public Service Company, Cleveland, Ohio

THE electrical industry constitutes the world's best example of a paradox. Referred to, on the one hand, as a "giant" and pointed to with pride with the other as being "only an infant."

As Barnum might have said, "We have here, under one mammoth tent, 'Reddy Kilowatt,' the most powerful giant history has ever known. Possessing the strength of twenty-five million horses, he was captured and subjugated at the cost of thousands of lives and eight billions of dollars. Step up, ladies and gentlemen, and view with alarm this wonderful monster! Please step quietly, however, because 'Reddy' is only just a 40-year-old infant and must sleep at least 60 per cent of the time."

Are we electrical men "business men" or just disseminators of platitudes? "Our capital turnover is only once in five years." Is that worth so much as an alibi that we should be content to retain it as our principal stock in trade?

How much would your company's net earnings be increased if operating expenses were cut 20 per cent? That's a lot of money, isn't it? And you know that expenses cannot be reduced to that extent. You can get the same amount of increased earnings, however, by raising your annual load factor just 10 per cent; not ten points, probably only five points, from 45 per cent to 50 per cent, for example.

Don't let anybody tell you that your annual load factor cannot be increased. Proper sales effort will do it—that and nothing else.

There are 8,760 hours in the year. Our giant is working less than 4,000 of those hours. If the electric light and power company that, in 1925, had an annual load factor of 45 per cent and earned 8 per cent on its investment could double its kilowatt-hour sales, it could reduce rates 25 per cent and still earn more than 10 per cent. How would that company stand with the public and regulatory bodies?

Let's wake our sleeping giant.

An Industry Balance Sheet

National Survey of Light and Power Business Gives Astonishing Data and Establishes New Business Principles—Gross Income Possibilities $7,211,817,484 at Virtually the Same Rate per Kilowatt-Hour

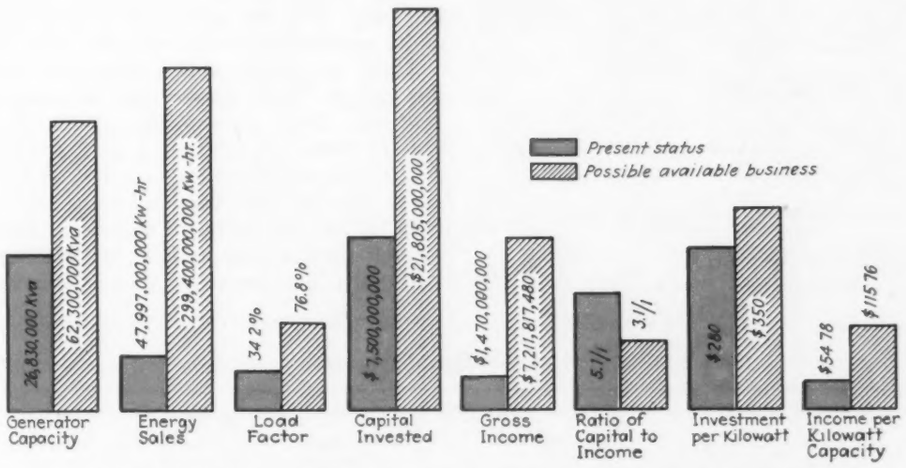


FIG. 1—COMPARISON OF PRESENT AND AVAILABLE CENTRAL-STATION BUSINESS

THIS article is an analysis of the business situation in the light and power industry. It is based on a study of all available data, opinion and general information and is an attempt to strike a balance between what has been done and what can be done. It also serves to develop trends and principles of value.

The data show the present business done in each class of service, the gross income from each class of service, the total investment in system capacity for each class of service and the influence of the different classes of business on the total system characteristics, investments and revenues.

Going further, a study was made and data were compiled to show the present business possibilities of the light and power industry in each class of business based on conservative estimates and saturated conditions. These opportunities for service were measured in terms of available markets by taking present revenues, rates and investments and then assuming conditions at each service outlet necessary to get the business. These were added to give the total national facts and figures. Also the load characteristics were weighed and balanced in terms of present and possible investments, operating costs and revenues. No future elements of growth were considered in the survey. The object was to survey the present status of electrification and measure the present possibilities.

The results of the study are astonishing. Only 10 per cent of the present available market is served by the light and power utilities. The staggering class business and total business figures give a guide to the industry that should be invaluable, and the analysis of these figures gives answers to many problems that have vexed the industry for many years. Rate structure, load factor, intensified business, are some of the elements that can be treated more intelligently through the application of the principles established. Also many industry opinions almost axiomatic in character can be questioned seriously and modified greatly in the light of this study.

The editors did not anticipate the facts or the principles, but proceeded in a fundamental manner to measure present service and possible service in each class of business and then added these to get totals. After

Table I—Domestic Load Is a $3,000,000,000 Business

	Per Customer	Total for Country, 14,532,930 Customers	2,600,000 Additional Unwired Homes in Reach of Lines	Total Available 17,132,930 Customers
Present business done:				
Average annual consumption, kw.-hr	365	5,604,579,450	1,049,000,000	6,653,579,450
Average residence bill, at 7.64 cents per kw.-hr.	$27.89	$438,185,285	$72,614,000	$510,799,285
Installed capacity, lighting and appliance, kw	1.5	21,799,395	3,900,000	25,699,395
Total load at 300 watts maximum demand, kw	0.3	4,359,879	780,000	5,139,879
Load factor, per cent	13.9			
Available present business:				
Annual energy consumption, kw.-hr.	5,754	83,622,479,220	14,960,400,000	98,622,479,200
Annual residence bill at average rate of 3.52 cents	$202.88	$2,948,440,838	$527,488,000	$3,475,928,838
Installed capacity, lighting and appliances, kw.	17.31	251,565,018	45,006,000	296,671,018
Total load at 3,000 watts maximum demand, kw.	3	43,598,790	7,800,000	51,398,790
Load factor, per cent	22	22		

this had been done the results were analyzed. This task was made easy because the light and power industry has freely published full information about its business and has established a statistical record of its accomplishments. And only because of the open books of the industry and the remarkable fund of information available was it possible to make such a survey with any degree of accuracy. It is the hope of the editors that the industry will use the study and the principles to build still more rapidly and constructively.

Table Ia—Present and Available Central Station Capacity, Sales and Income

	Present Business	Present Available Business
Operating aspects:		
Total generator rating, kva.	26,830,000	62,300,000
Total energy generated, kw.-hr.	59,517,000,000	369,400,000,000
Energy sold to customers, kw.-hr.	47,997,000,000	299,266,827,200
Customers' utilization equipment, installed capacity, kw.	43,528,900	400,248,000
Capacity factor of generating stations, including line loss and intracompany sales (per cent)	25.2	67.6
Capacity factor of central stations, based on sales to customers (per cent)	20.2	54.9
Composite national maximum demand (kw.)	16,000,000	44,500,000
Composite national diversity factor	1.61	3.33
Composite national load factor (per cent)	34.2	76.8
Financial and commercial aspects:		
Capitalization of central-station industry	$7,500,000,000	$21,805,000,000
Gross annual income	1,470,000,000	7,211,817,480
Rate of investment turnover	5.1 to 1	3.1 to 1
System investment per kva. of system capacity	$280	$350
System revenue per kva. of station capacity	$54.78	$115.76

The light and power industry has grown so that its annual gross revenue was $1,470,000,000 from the sale of 47,997,000,000 kw.-hr. during the year. It had a capital investment of $7,500,000,000 and a generating station capacity of 26,830,000 kva.

These staggering totals reduce to fundamental units and ratios. The industry has invested $5.10 of capital for each dollar of revenue. There is a turnover of capital therefore only once in five years—a very low rate compared with that experienced in industrial business. The average sales price per kilowatt-hour in the industry is 3.07 cents. The sale of kilowatt-hours per kilovolt-ampere installed in generating equipment is 1,785; the investment per unit of generating equipment

FUNDAMENTAL RATIOS

Table II—Rural Service

	Per Customer	Total for Country, 199,389 Farms with Service	10 per Cent (600,000) Farms in Reach of Line	Total 6,000,000 Farms in Country
Present business done:				
Average annual consumption, kw.-hr.	300	59,816,700	180,000,000	1,800,000,000
Average annual rural service bill, at 12 cents per kw.-hr.	$36.00	$7,178,004	$21,600,000	$216,000,000
Installed capacity, lighting and appliances, kw.	1.5	299,083	900,000	9,000,000
Load at 500 watts maximum demand	0.5	99,694	300,000	3,000,000
Load factor (per cent)	6.8	6.8	6.8	6.8
Miles of rural line (four customers per mile)	0.25	49,847	150,000	1,500,000
Available present business*:				
Annual energy consumption, kw.-hr.	3,433	684,492,437	2,059,800,000	18,000,000,000
Average annual rural service bill at 5.04 cents per kw.-hr.	$173.39	34,572,058	$104,034,000	$1,040,340,000
Installed capacity, lighting, appliances and power, kw.	13.59	2,709,696	8,154,000	81,540,000
Load at 2.5 kw. maximum demand	2.5	498,472	1,500,000	15,000,000
Load factor (per cent)	15.6	15.6	15.6	15.6
Miles of rural line (four customers per mile)	0.25	49,847	150,000	1,500,000

*Based on well-applianced home and moderate use of power.

Table III—Commercial Lighting, Signs and Windows

	Connected Load, Kw.	Annual Consumption, Kw.-Hr.	Time and Season of Peak	Average Rate per Kw.-Hr., Cent	Annual Revenue	Load Factor Based on Capacity Installed
Present business done:						
Total commercial lighting customers (2,781,280)	4,209,480	5,900,000,000	Evening–winter	5.75	$339,260,000	16
Possible additional load (50 per cent increase in connected load)	2,104,740	3,540,000,000	Evening–winter	5.00	$177,000,000	19.5
200,000 additional customers	450,000	954,000,000	.....	5.00	47,700,000	19.5
	2,554,740	4,494,000,000		5.00	224,700,000	
Total available load	6,763,220	10,394,000,000	Evening–winter	5.50	$563,960,000	17.5

Table IIIa—Industrial Motor Load Served by Central-Station Companies

Industry	Hp. in Motors	Kw. Equivalent	Annual Consumption, Kw.-Hr.	Time of Peak	Average Rate, per Kw.-Hr. Cents	Annua Revenue	Load Factor
Present business done:							
Chemical and allied products	1,019,519	764,637	3,379,952,000	Summer–night	0.008	$26,932,000	50
Food products	1,709,566	1,282,173	2,670,520,000	Fall–day	0.015	40,000,000	23
Iron and steel	1,931,549	1,448,661	2,393,789,000	Fall–day	0.016	38,200,000	19
Leather	190,000	143,076	243,560,000	Winter–day	0.016	3,840,000	19
Lumber and woodworking	721,447	541,083	777,511,000	Summer–day	0.020	15,400,000	16
Machinery	1,512,813	1,134,609	1,190,894,000	Winter–day	0.028	33,700,000	12
Metals not iron and steel	696,152	537,114	1,095,928,000	Spring–day	0.015	16,300,000	23
Musical instruments	36,871	27,654	27,940,000	Summer–day	0.029	785,000	11
Paper and printing	848,065	636,048	2,262,323,000	Spring–day	0.010	22,623,000	40
Railroad repair shops	423,595	317,694	360,079,000	Winter–day	0.025	1,440,000	13
Rubber products	333,234	249,924	558,259,000	Spring–day	0.013	14,800,000	25
Ceramics	949,384	712,038	1,139,421,000	Summer–day	0.017	19,200,000	18
Textiles	1,466,784	1,100,098	1,322,071,000	Summer–day	0.023	30,600,000	14
Tobacco	15,903	11,925	24,829,000	Fall–day	0.014	336,000	22
Transportation	1,142,076	856,557	1,451,914,000	Spring–day	0.015	21,700,000	20
Coal mines	889,539	667,155	1,819,200,000	Fall–day	0.011	20,800,000	31
Metal mines and quarries	694,907	521,178	676,200,000	Summer–day	0.022	1,490,000	15
Ice and refrigeration	550,000	412,500	1,051,200,000	Summer–night	0.012	12,600,000	28
Miscellaneous	361,368	271,026	474,732,000	Winter–night	0.015	7,100,000	20
Total, all industries	15,514,542	11,620,170	22,940,322,000	Summer–day	0.014	$327,846,000	22.5

Table IV—Industrial Power Not Supplied from Lines of Central-Station Companies

(Additional available load)

Industry	Electric Motor Load Served from Isolated Plants, Hp. in Motors	Power Supplied from Steam, Gas and Oil Engines, Hp.	Total Kw. Equivalent of Industrial Power Not Supplied by Central Stations	Total Annual Energy Consumption, Kw.-Hr.	Time of Peak	Average Rate per Kw.-Hr., Cents	Annual Revenue	Load Factor
Chemical and allied products	674,556	1,044,530	1,289,313	2,634,665,000	Summer–night	1.4	$36,800,000	23
Food products	513,037	1,500,527	1,510,173	3,310,572,000	Fall–day	1.3	43,000,000	25
Iron and steel	3,029,828	2,281,973	3,983,916	6,505,003,000	Fall–day	1.6	91,400,000	19
Leather	123,029	99,162	166,641	288,604,000	Winter–day	1.5	4,300,000	20
Lumber and woodworking	507,329	2,107,557	1,961,163	3,010,199,000	Summer–day	1.9	52,600,000	17
Machinery	740,352	14,020	565,779	513,413,000	Winter–day	3.0	15,090,000	10
Metals not iron and steel	283,544	188,997	339,405	682,201,000	Spring–day	1.4	9,500,000	23
Musical instruments	39,078	14,280	40,017	39,860,000	Summer–day	2.9	1,100,000	11
Paper and printing	653,081	1,241,547	1,420,971	5,002,816,000	Spring–day	1.0	50,000,000	40
Railroad repair shops	271,731	111,109	287,130	327,311,000	Winter–day	2.5	8,200,000	13
Rubber products	180,799	91,601	204,300	468,815,000	Spring–day	1.2	5,600,000	26
Ceramics	424,996	544,455	727,086	1,137,722,000	Summer–day	1.7	19,300,000	18
Textiles	911,262	1,422,314	1,750,107	2,173,031,000	Summer–day	2.3	50,000,000	14
Tobacco	15,254	12,324	20,682	27,024,000	Fall–day	2.2	600,000	15
Transportation	453,972	71,920	394,325	1,317,032,000	Spring–day	1.3	17,200,000	26
Coal mines	893,214	380,089	954,975	2,608,200,000	Fall–day	1.2	31,200,000	30
Metal mines and quarries	339,086	170,549	372,374	475,000,000	Summer–day	2.3	10,900,000	14
Ice and refrigeration	50,000	500,000	412,500	1,051,200,000	Summer–day	1.2	12,600,000	28
Miscellaneous	66,721	148,382	169,325	313,783,000	Winter–night	1.5	4,700,000	21
Total all industries	10,170,869	11,446,726	16,213,194	31,886,451,000	Fall–day	1.45	$464,000,000	22.4

	Installed Capacity, Kw.	Total Demand, Kw.	Annual Consumption, Kw.-Hr.	Load Factor	Average Rate, Cents	Total Annual Revenue
Total available load all industries	27,833,364	27,833,364	54,826,773,000	22.4	1.42	$791,846,000

is $279 and the revenue per kilovolt-ampere of station capacity is $54.76.

The survey shows that the present possibilities of the industry are as follows: Gross income, $7,211,817,484; annual kilowatt-hour sales, 299,266,827,200; capitalization, $21,805,000,000; total generator rating, 62,300,000 kva.

In fundamental units these totals reduce to the following: Turnover or dollars investment per dollar of income, 3.1; average sale price per kilowatt-hour, 2.76 cents; kilowatt-hours sold per kilovolt-ampere of generating capacity, 4,820; investment per kilovolt-ampere of station capacity, $350; gross revenue per unit of generating capacity, $115.76.

This comparison of total and unit figures on the basis of what has been done and what is available as a present market is rather startling and leads to serious analyses. Naturally, the figures have been scrutinized very carefully and have been checked again and again. The editors believe they can be published as a reasonably accurate industry market balance sheet. Every variable in the business has been weighed and used in arriving at the totals, and it is believed they are reasonable, even though minor criticisms might be made. The following table gives the results briefly:

	Present	Available	Ratio
Capitalization per dollar revenue, dollars	5.1	3.5	1.45 : 1
Average sale price per kilowatt-hour, cents	3.07	2.76	1.11 : 1
Kilowatt-hours sold per kilovolt-ampere of station capacity	1,875	4,820	1 : 2.57
System investment per station kilovolt-ampere, dollars	279	350	1 : 1.25
System revenue per station kilovolt-ampere, dollars	54.78	115.76	1 : 2.11

These comparisons and ratios are striking; average rates are changed only slightly, yet the revenue per unit of station capacity is more than doubled. Capital

Table V—Industrial Electric Heating Load of 44,300,000 Kw. Available

	Installed Capacity, Kw.	Annual Consumption, Kw.-Hr.	Time and Season of Peak	Average Rate per Kw.-Hr., Cents	Annual Revenue	Load Factor Based on Capacity Installed
Present business done:						
Heat treating	300,000	657,000,000	Night–summer	1.5	$9,855,000	25
Industrial ovens	240,000	525,600,000	Night–spring	1.6	8,409,600	25
Brass melting	128,000	394,000,000	Day–winter	1.3	5,120,000	35
Steel melting	245,000	439,700,000	Night–spring	1.0	4,397,000	20
Miscellaneous applications	400,000	926,000,000	Day–fall	2.5	23,150,000	26
Total	1,313,000	2,932,300,000	Night–summer	1.7	$50,931,600	25

	Potential Installed Capacity, Kw.	Annual Consumption, Kw.-Hr.	Time and Season of Peak	Average Rate per Kw.-Hr., Cents	Annual Revenue	Load Factor Based on Capacity Installed
Present available load:						
Large heat treating	30,000,000	66,000,000,000	Night–summer	1.5	$990,000,000	25
Small heat treating	957,000	1,680,000,000	Night–summer	2.0	33,600,000	20
Industrial ovens	1,000,000	2,750,000,000	Day–winter	1.5	41,250,000	31
Melting pots	285,000	435,000,000	Day–summer	2.0	8,700,000	23
Air, conduction and immersion heaters	2,000,000	3,500,000,000	Day–winter	2.0	70,000,000	20
Brass melting	750,000	2,130,000,000	Day–winter	1.3	27,690,000	32
Steel melting	8,000,000	14,000,000,000	Night–spring	1.0	140,000,000	20
Total	42,992,000	90,495,000,000	Night–summer	1.33	$1,211,240,000	24
Total available load	44,305,000	93,427,300,000	Night–summer	1.33	1,262,171,600	..
Future possibilities—deferred load:						
Forging furnaces	10,000,000	30,000,000,000	.....	1.4	$633,300,000	25
Ceramic and glass furnaces	4,000,000	9,900,000,000	.....	1.0	99,000,000	30
Glass annealing	4,000,000	9,900,000,000	.....	1.0	99,000,000	30
Paper	5,000,000	15,300,000,000	.....	1.0	15,300,000	35
Total	23,000,000	65,100,000,000	.....	1.3	$846,600,000	32

turnover is increased 40 per cent, yet system investments have increased only 25 per cent. Sales of energy per unit of station capacity have increased two and a half times.

How is it possible that such a remarkable increase in sales is not accompanied by a correspondingly large reduction in average rates? How is it possible to sell such large amounts of energy per unit of capacity without increasing the investment enormously? These and many other questions will occur to any student of the industry who reads these totals.

METHOD OF SURVEY AND SCOPE

As a preliminary to the development of these principles it is well to include at this point the basic elements of the survey, the method of analysis and the data obtained. The study has been made by industry divisions to determine the answers to the following questions: To what extent has each class of business been developed? How much additional load is available? What are the present and possible load factors? What rates are reasonable to secure the possible business? What is a reasonable yardstick to use in measuring possibilities in each class of business? What effect will the addition of each class of load have on the engineering, financial and operating aspects of the business? The classes of business considered on this basis were as follows: Domestic customers, rural customers, commercial lighting, industrial heating and commercial cooking, railroads and railways, industrial power load, miscellaneous uses such as street lighting, battery charging and traffic signals.

At the close of 1925 the sources of utility income were divided into the following assumed but reasonable percentages: Domestic, 29.8; industrial heating, 3.6; motor load, 22.2; commercial cooking, 0.6; railroads and railways, 4.8; miscellaneous uses, including street lighting, 15.4. Tables I to VIII show in detail the characteristics, connected load, demand, energy consumption, load factor, time of peak, rate and gross income received from each of the foregoing classes of business and also the same data for the possible or available national load. In considering the available additional load each class of business has been treated separately and the rate per kilowatt-hour has been taken as that which would be economical and advantageous primarily from the customer's standpoint. The load factors for each class of business are on an annual basis and should not be confused with the daily load factors of single industrial plants.

Character of Loads

Domestic Load.—Considering the different classes of business, the domestic load offers the greatest possibilities for building energy sales and increasing revenue. The residential consumption throughout the country is notoriously low and on a national basis this load is only 7.3 per cent developed. The 14,532,930 residential customers in the United States consumed 5,604,579,450 kw.-hr., for which they paid $438,185,285 in 1925—an average annual consumption of 365 kw.-hr. and bill of $27.89 at 7.64 cents per kilowatt-hour. Experience with well-applianced electrical homes has demonstrated that it is entirely practicable for a householder to use from 12 to 20 kw. of electrical equipment consuming between 4,000 and 6,000 kw.-hr. annually. The equipment for such a home is shown in Table IX. This installation includes the use of an electric range, refrigerator and water heater, the latter operating mostly at night or by means of an automatic cutout at times when other devices are not in use. Such domestic installations, a number of which have been made throughout the country, produce a very desirable load, with a fairly even demand throughout the day and night and a load factor of 22 per cent at a 3-kw. maximum demand. An average rate of 3.52 cents is not out of line for a load of these characteristics and the annual bill of $202.88 is in sharp contrast to present average conditions. The potential domestic load will produce more than twice the present total gross income of all the central-station companies combined.

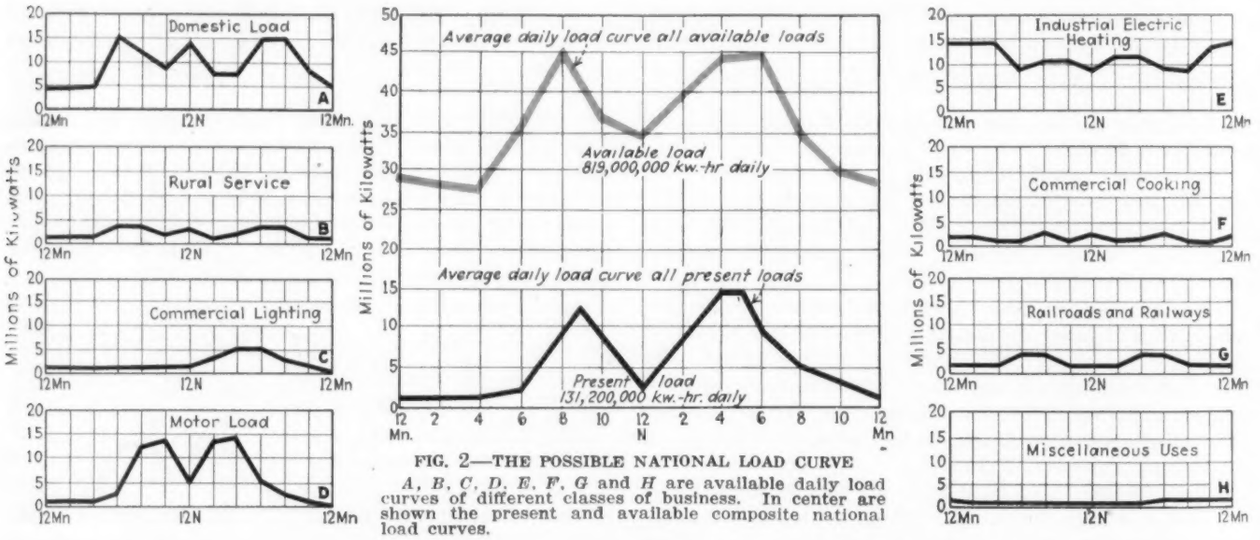


FIG. 2—THE POSSIBLE NATIONAL LOAD CURVE

A, B, C, D, E, F, G and *H* are available daily load curves of different classes of business. In center are shown the present and available composite national load curves.

Rural Service.—Farm electrification as so far developed resembles the domestic load. The value of extensive electric power applications to agriculture has yet to be proved, but the most urgent need and desire of the farmer are to obtain the benefits of electric service enjoyed by his urban cousin. To enable the full use of electric service the rural customer should have ample electrical equipment, and a practical installation for the farm home is given in Table X, showing the energy

consumption, rate to encourage use and annual bill. Load characteristics of this business are also similar to those of the domestic customer, with a somewhat lower load factor of 15.6 per cent. Most recent figures show that there are 199,381 farms with electric service. There are roughly 6,000,000 farms in the country and electrification of 10 per cent of these will add $100,000,000 to the power companies' income. If all of the farms in the country could be reached, the total revenue would be more than two-thirds of the electric utilities' annual income at the present time.

Commercial Lighting.—This class of business shows the highest state of development—62.1 per cent of any class of business—due probably to the fact that the merchant is quicker to grasp the advantages of good illumination. There is still much work to be done in increasing illumination, new customers have been added at the rate of almost 200,000 per year and sign lighting has never been adequately sold. Also with better lighting the average storekeeper increases his daily hours' use of the installation.

Industrial Power.—As it exists today, 11,629,170 kw., or 43.5 per cent of the total industrial power load, is served by the central-station companies, leaving 56.5 per cent, or 16,213,194 kw., supplied either by private generating plants or by some other form of power. A study of the industrial motor load by major industry classifications shows that in but very few industries, chiefly the iron and steel, lumber and paper-making industries, is there any tendency toward the operation of private plants or the retention of other forms of power than electric. The reasons for this are obvious, but the fact that between 25 and 30 per cent of these industries' power requirements are already supplied by the electric utilities shows that they may be fairly classed as potential power purchasers. The addition of the available motor load offers many opportunities for developing business that will help to fill up some of the valleys in the daily load curve. The potential market for this class of service is one and one-half times the present industrial power load.

Industrial Electric Heating, Commercial Cooking.—This application has long been recognized as possessing huge possibilities for load development. The possibility of operating electric-heating equipment principally during off-peak hours, its high load and power factor make this class of business one of the most desirable that a power company can add to its lines. It is so far only 2.9 per cent developed, and beyond the electric applications that have been proved economically practicable there are other possibilities that must be classed as deferred loads but that cannot be overlooked.

Commercial electric cooking is another branch of heavy-duty heat application that has very attractive load characteristics and that is only 5.1 per cent developed at present.

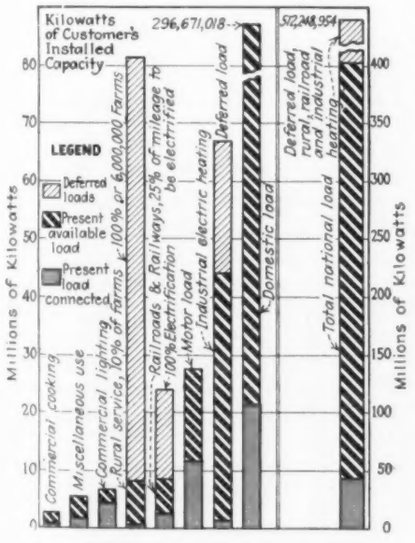


FIG. 3—INSTALLED CAPACITY OF THE PRESENT AND AVAILABLE NATIONAL LOAD

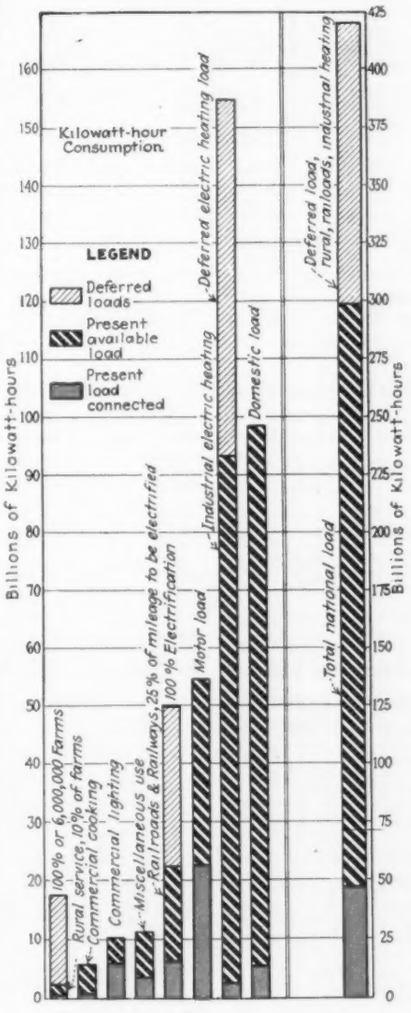


FIG. 4—ENERGY CONSUMPTION OF PRESENT AND AVAILABLE NATIONAL LOAD

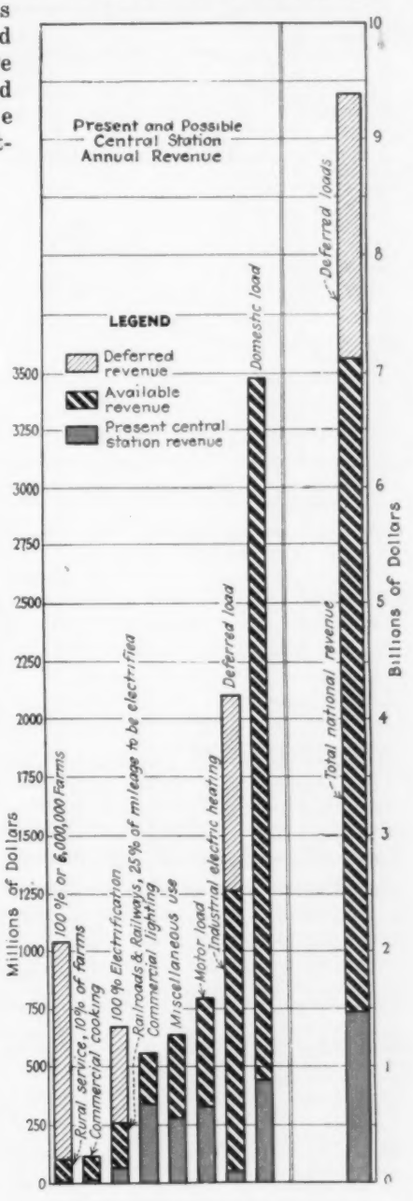


FIG. 5 — PRESENT AND AVAILABLE CENTRAL-STATION REVENUE FROM ENERGY SALES

Table VI—Commercial Electric Cooking, 2,716,000 Kw.

	Installed Capacity, Kw.	Annual Consumption, Kw.-Hr.	Time and Season of Peak	Average Rate per Kw.-Hr., Cents	Annual Revenue	Load Factor Based on Capacity Installed
Present business done:						
Electric bake ovens, ranges, bakery and restaurant equipment	140,000	302,400,000	Day-night	3.0	$9,072,000	24
Present available load:						
164,361 restaurants, bakeries, hotels and institutions in the United States	2,576,200	5,538,830,000	Day-night	2.0	110,776,600	25
Total available load	2,716,200	5,841,230,000	Day-night	2.0	$119,848,600	25

Table VII—Electrification of Railroads and Railways, 22,700,000,000 Kw.-Hr.

	Miles of Line, Total	Miles of Line Electrified	Annual Consumption, Kw.-Hr.	Time and Season of Peak	Annual Income	Rate per Kw.-Hr.	Generator Capacity Based on 30 per Cent Load Factor Average Use
Present business done:							
Railroads	220,000	3,214	609,161,850	Morning–evening	$6,700,780	1.1	231,682
Railways	46,800*	30,420*	5,850,838,150		64,359,220	1.1	2,182,040
	266,800	33,634	6,460,000,000		$71,060,000	1.1	2,413,722
Present available load†:							
Railroads	.....	51,786	12,946,500,000	Morning–evening	$142,411,500	1.1	4,937,100
Railways	.....	16,480	3,296,000,000		36,356,000	1.1	1,254,180
	.....	68,266	16,242,500,000		$178,767,500	1.1	6,191,280
Total available load	.....	.....	22,702,500,000	Morning–evening	$249,827,500	1.1	8,604,002

* 65 per cent of electric street railways purchase power.

† Based on sale of all energy required by street railways and electrification of 25 per cent of present steam railroad mileage.

Table VIII—Miscellaneous Uses, 5,202,150 Kw.

(Including street lighting, traffic signals, battery charging, etc.)

	Connected Load, Kw.	Annual Consumption, Kw.-Hr.	Time and Season of Peak	Average Rate per Kw.-Hr., Cents	Annual Revenue	Load Factor
Present business done:						
Street and highway lighting, trucks, miscellaneous, traffic signals	1,734,050	3,797,581,850	Night–winter	5.96	$226,466,946	25
Available additional business:						
Street and highway lighting, trucks, miscellaneous, traffic signals	3,468,100	7,595,163,700	Night–winter	5.5	$417,734,000	25
Total available load	5,202,150	11,392,745,000	Night–winter	5.65	$644,200,946	25

Table IX—Electrical Equipment Capacity, Energy Consumption of a Well-Applianced Home

(Based on a Six-Room House, "Red Seal" Standard)

Equipment	Rating, Watts	Kw.-Hr. per Year	Time and Season of Peak	Rate to Encourage Use, Cents	Annual Income
Fan	40	16	Summer–day	7	$1.12
Room heater	600	40	Fall–day	5	2.00
Flatiron	550	72	Summer–day	7	5.04
Ironer	1,100	200	Summer–day	5	10.00
Toaster	500	45	Summer–day	5	2.25
Percolator	450	50	Summer–day	5	2.50
Waffle iron	600	20	Winter–day	6	1.20
Curling iron	30	6	Summer–day	7	.42
Vacuum cleaner	50	30	Summer–day	7	2.10
Dishwasher	150	50	Winter–day	6	3.00
Clothes washer	300	25	Summer–day	7	1.75
Chafing dish	550	25	Winter–night	5	1.25
Heating pad	150	15	Winter–night	7	1.05
Fireless cooker	550	100	Summer–day	5	5.00
Sewing machine	40	10	Summer–day	7	.70
Kitchen lighting unit	150	75	Winter–night	6	4.50
Other lighting	1,500	300	Winter–night	6	18.00
Range	7,500	1,500	Summer–day	3.5	52.50
Refrigerator	300	700	Summer–day	5	35.00
Water heater	2,000	2,400	Winter–night	2	48.00
Radio	100	75	Winter–night	6	4.50
Total	17,310	5,754		3.52	$202.88

Table X—Electrical Equipment Capacity, Energy Consumption of Well-Equipped Rural Customer

Appliance	Rating, Watts	Kw.-Hr. per Year	Time and Season of Peak	Rate to Encourage Use, Cents	Annual Income
Fan	40	16	Day–summer	8	$1.28
Room heater	600	40	Day–fall	6	2.40
Electric iron	550	72	Day–summer	8	5.76
Vacuum cleaner	50	30	Day–summer	8	2.40
Washing machine	300	25	Day–summer	8	2.00
Toaster	500	45	Day–summer	5	2.25
Percolator	450	50	Day–summer	5	2.50
Refrigerator	300	700	Day–summer	5	35.00
Range	7,500	1,500	Day–summer	4	60.00
Pump motor	200	180	Day–summer	6	12.80
Lighting	750	200	Night–winter	8	16.00
Radio	100	75	Night–winter	8	6.00
3-hp. utility motor	2,250	500	Day–fall	5	25.00
	13,590	3,433		5.04	$173.39

Table XI—Installed Capacity Present and Possible National Load—All Classes of Business

(Based on kilowatts of customers' installed capacity)

Class of Business	Present Status, Kw. Connected	Available Load, Kw. Connected	Per Cent Developed
Domestic load	21,799,395	296,671,018	7.3
Rural service	299,083	8,154,000	3.7
Commercial lighting	4,209,480	6,763,220	62.1
Motor load	11,620,170	27,833,364	43.5
Industrial electric heating	1,313,000	44,305,000	2.9
Commercial cooking	140,000	2,716,200	5.1
Railroads and railways	2,413,722	8,604,002	28.0
Miscellaneous uses	1,734,050	5,202,150	33.3
Total	43,528,900	400,248,954	10.8

Table XII—National Load, Energy, Consumption and Revenue from All Classes of Business

	Installed Capacity, Kw.	Total Maximum Demand, Kw.	Annual Consumption, Kw.-Hr.	Load Factor, Per Cent	Average Rate, Cents	Total Annual Revenue	Per Cent of Total Revenue
Present status:							
Domestic load	21,799,395	4,359,879	5,604,579,450	13.9	7.64	$438,185,450	29.3
Rural service	299,083	99,694	59,816,700	6.8	12.00	7,178,004	0.5
Commercial lighting	4,209,480	4,209,480	5,900,000,000	15.6	5.75	339,260,000	23.1
Motor load	11,620,170	11,620,170	22,940,322,000	22.5	1.40	327,846,000	22.2
Industrial heating	1,313,000	1,313,000	2,932,300,000	25.0	1.70	50,931,600	0.6
Commercial cooking	140,000	140,000	302,400,000	24.6	3.00	9,072,000	4.6
Railroads and railways	2,413,722	2,413,000	6,460,000,000	30.0	1.10	71,060,000	4.8
Miscellaneous use	1,734,050	1,734,050	3,797,581,850	25.0	5.50	226,466,946	15.4
Total	43,528,900	16,000,000*	47,997,000,000	34.2*	3.07	$1,470,000,000	100.0
	Installed Capacity, Kw.	Total Maximum Demand, Kw.	Annual Consumption, Kw.-Hr.	Load Factor, Per Cent	Average Rate, Cents	Total Annual Revenue	Per Cent of Total Revenue
Possible national load:							
Domestic load	296,671,018	51,398,790	98,622,479,200	22.0	3.52	$3,475,928,838	48.2
Rural service	8,154,000	1,500,000	2,059,800,000	15.6	5.04	104,034,000	1.4
Commercial lighting	6,763,220	6,763,220	10,394,000,000	17.5	5.50	563,960,000	7.8
Motor load	27,833,364	27,833,364	54,826,773,000	22.4	1.42	791,846,000	11.0
Industrial heating	44,305,000	44,305,000	93,427,300,000	25.0	1.33	1,262,171,600	17.5
Commercial cooking	2,716,200	2,716,200	5,841,230,000	24.0	2.00	119,848,600	1.7
Railroad and railways	8,604,002	8,604,002	22,702,500,000	30.0	1.10	249,827,500	3.5
Miscellaneous use	5,202,150	5,202,150	11,392,745,000	25.0	5.50	644,200,946	8.9
Total	400,248,954	44,500,000*	299,266,827,200	76.8*	2.76	$7,211,817,484	100.0

* From graph of national composite load curves.

Railroads and Railways.—Street railways and interurban companies are already purchasing about 65 per cent of their power requirements, but the big field for further development of this type of load is in the electrification of steam railroads, which in their recent electrification programs have shown a marked tendency to contract for power rather than construct their own generating stations. On much of the existing railroad mileage the traffic density is not considered sufficiently heavy to warrant electrification, but fully 25 per cent of the present lines could be profitably operated electrically. Except in the metropolitan areas where commuting service creates morning and evening peaks this business offers a very attractive load, operating at close to 30 per cent load factor. Electrification of the railroads on the basis that is now considered practicable will return to the central-station industry more than $250,000,000 annually.

Miscellaneous Uses.—Street lighting, battery charging and traffic signals make up the principal miscellaneous uses, and the possibilities here present an opportunity for much random speculation. Street-lighting intensities are constantly being increased and additional highway lighting installed. Electric trucks are used for only about 4 per cent of the city transportation in which they are the most economical. Traffic signal systems are just emerging from the experimental stage. A conservative estimate of available load may be taken as twice the present business.

Validity of Data

The data given in Tables I to VIII showing the present and possible loads for each class of business are based upon definite information, surveys and investigations made by different companies in widely separated parts of the country. The characteristics of each load have been carefully studied and the total data derived from actual operating installations and not from arbitrary assumptions. From the domestic load the possibility of increasing the residential customer's use of energy to 5,754 kw.-hr. annually has been practically demonstrated and definite figures giving the energy consumption and revenue from well-equipped electrical homes show the data in Table IX to be conservative. Similarly for the rural load no extraordinary use of energy has been contemplated and only 10 per cent of the farms in the United States have been considered.

The industrial motor load present and possible is taken from an actual inventory of the industrial load as published in the ELECTRICAL WORLD for Jan. 2.

Table XIII—Load Factors of Large Utilities Unimproved

Company	1917	1918	1919	1920	1921	1922	1923	1924	1925	Points Change 1917–1925
1.	44.6	43.5	44.6	45.1	42.0	42.5	47.0	45.5	44.5	— 0.1
2.	39.2	38.2	38.5	39.7	40.0	38.1	40.5	39.5	40.2	+ 1.0
3.	54.4	54.5	58.3	57.7	58.6	57.2	56.5	57.4	57.3	+ 2.9
4.	61.6	63.1	60.7	65.2	63.9	62.5	64.1	62.6	60.2	— 1.4
5.	50.4	51.3	47.4	52.4	51.9	49.5	51.2	49.7	50.8	+ 0.4
6.	46.2	48.9	45.1	48.1	44.0	43.8	44.2	40.8	44.0	— 2.2
7.	46.0	47.6	41.4	51.1	49.8	41.9	45.3	44.9	48 1	+ 2.1
8.	54.0	51.9	45.0	57.4	48.7	46.9	55.2	52.1	52.8	— 1.2
9.	45.0	48.3	43.0	50.5	45.9	43.5	49.6	43.4	45.7	+ 0.7
10.	68.6	64.2	67.2	66.3	57.6	51.3	56.8	56.5	53.3	—15.3
11.	52.7	64.4	65.9	57.0	47.5	47.6	53.0	49.7	52.5	— 0.2
12.	46.0	46.8	47.8	50.9	47.6	45.4	47.9	46.8	50.2	+ 4.2
13.	62.4	64.9	54.9	55.1	43.9	46.7	55.9	51.5	51.0	—11.4
14.	48.0	48.0	43.5	48.4	42.1	42.7	47.1	71.1	44.1	— 3.9
15.	36.1	35.0	36.4	42.5	33.2	37.3	39.3	38.2	36.6	+ 0.5
16.	37.5	37.5	35.4	36.8	36.1	35.8	39.3	35.9	40.0	+ 2.5
17.	44 0	42.8	46.0	44.8	43.5	41.5	50.5	49.1	54.0	+10.0
18.	38.6	38.1	31.2	45.8	38.5	39.9	48.5	38.1	34.6	— 4.0
19.	58 5	65.1	43.6	63.0	60.0	52.1	55.6	52.0	55.0	— 3.5
20.	56.7	51.5	47.7	57.0	23.2	45.9	54.5	49.5	48.1	— 8.6
21.	73.4	67.6	58.6	65.4	56.5	48.6	53.9	48.3	52.4	—21.0

Table XIV—Daily Load Factors of Representative Utilities Are Stationary

Company	Type	Summer 1920	Summer 1924	Winter 1920	Winter 1924	Change Summer	Change Winter
A	Metropolitan	65.4	61.5	61	61.7	— 3.9	+0.7
B	Metropolitan	59.5	62.0	63	67.5	+ 2.5	+4.5
C	Metropolitan	69.2	68.5	68.5	70.2	— 0.7	+1.7
D	Metropolitan	62.6	52.3	62.1	61.8	—10.3	—0.3
E	Transmission	65.0	60.0	58.6	....	— 5.0	.....
F	Metropolitan	72.0	71.3	75.4	69.5	— 0.7	—5.9
G	Metropolitan	52.0	61.0	63.2	65	+ 9.0	+2.8
H	Metropolitan	63.0	63.8	64.0	59.6	+ 0.8	—4.4
I	Transmission	60.0	60.0	64.7	67.5	0	+2.8
J	Metropolitan	71.1	70.4	70.3	71.4	— 0.7	+1.1
K	Transmission	88.2	84.0	80.6	73.9	— 4.2	—6.7
L	Metropolitan	75.0	74.6	70.0	70.0	— 0.4	0
M	Transmission	45.0	61	57.6	54.0	+16	—3.6
N	Metropolitan	70.2	71.6	66.8	68.2	+ 1.4	+1.4
O	Transmission	79.7	75.4	66.5	75.8	— 4.3	+9.3
P	Transmission	72.2	77	68.4	76.2	+ 4.8	+7.8
Q	Metropolitan	63.0	51.4	63.0	54.0	—11.6	—9.0
R	Metropolitan	68.5	67.8	62.0	66.6	— 0.7	+4.6

Present and possible railway and railroad loads are taken from accurate information on their present use of electric energy. In determining the available load it has been considered as economically practicable to electrify only 25 per cent of the total miles of steam railroad.

Industrial electric heating and commercial cooking are also measured in the light of what has been accomplished in the electrification of these applications so far Energy consumption, demand and load factor represent

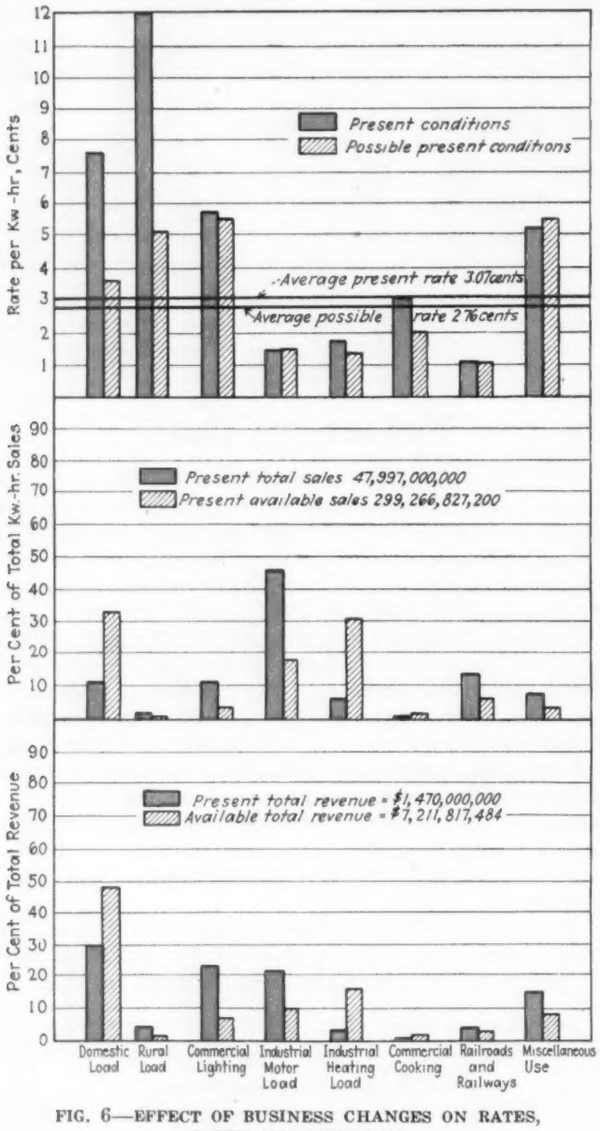


FIG. 6—EFFECT OF BUSINESS CHANGES ON RATES, SALES AND REVENUES

the actual experience of companies that have developed this load. The available national load is based on a national inventory of heat applications that are economically sound. Dubious uses such as house heating have been excluded and many bulkheat applications are shown as deferred load merely to indicate future possibilities.

Commercial lighting and miscellaneous uses have been very conservatively estimated on the basis of the existing business and no attempt has been made to allow for new or undeveloped uses. The total possible national load is considered only that which is available at the present time.

The Composite National Load

The sums of the total demand, energy consumption and revenue of the present load compared with those of the possible loads disclose a vast opportunity not only for increasing the central-station industry's total revenue fivefold but also for effecting many financial and operating economies for the electric utilities. Analysis of the different classes of prospective business shows a wide diversity in the occurrence of their daily and seasonal peaks. Much of the available load, notably industrial heating, commercial cooking and domestic water heating, can be operated most satisfactorily at night—the present off-peak hours. Railroad electrification when applied on a national basis will provide a fairly level daily load curve. Lighting has in many instances ceased to be a peak load. Although the present motor load is responsible for a marked day peak in many companies, it will, with the addition of other loads, lose its peak responsibility. With these elements in mind, the charts *A*, *B*, *C*, *D*, *E*, *F*, *G* and *H* on page 974 were plotted to show the average daily load curve for each class of business.

AVERAGE CLASS LOAD CURVES ADDED TO GET THE TOTAL

The characteristics of each load were plotted in graphs, where each graph gives the average daily load characteristic based on the annual maximum demand and annual sales of energy. Using these curves as a basis, a national average daily load curve was plotted. This gives curve *A* with a maximum demand of 44,500,000 kw., a diversity factor between the different loads of 3.33 to 1 and an average daily and average annual load factor of 76.8 per cent.

On the assumption that there is allowed a 25 per cent margin in generating station capacity and a 12 per cent increase in maximum demand due to losses, the total generating capacity required to serve this national load is 62,300,000 kva.

The present load curve was plotted on the basis of the annual kilowatt-hours sold. The existing diversity factor between classes of business is 1.61. The maximum demand was computed by taking the present installed capacity of 26,830,000 kva. and deducting 20 per cent to cover intracompany business and losses and 25 per cent to cover the margin of reserve. This gave a maximum demand of 16,000,000 kw. and a present average daily and annual load factor of 34.2 per cent. The points on the present composite load curve were plotted by first plotting the average daily load curve based on the annual figures for each class of business and then summing the ordinates of these curves.

The basis of analysis was considered reasonably accurate, especially as the purpose of these curves was to depict average present and possible conditions in a general way for the purpose of establishing certain ratios and deducing certain principles. The quantitative data and detailed analyses made should not be taken as exact or free from minor errors and certain assumptions that must be made necessarily to plot average annual loads for each class of business for each hour of the day. It is felt, however, that the peak values are free from these assumptions, are reasonably accurate and that the total daily peaks are valid. No account has been taken of the possibility of further diversity in the time loads appearing on systems due to differences in time or to the habits of industry and people

in different territories. This would no doubt have a further tendency to reduce peaks and flatten the load curve. To serve the available load the total generating capacity will have to be increased to 62,300,000 kva., but a very considerable increase will have to be made in transmission and more particularly distribution systems so that an investment of $350 per kilowatt of system capacity may be expected, bringing the total investment in generating transmission and distribution facilities for the country to $21,805,000,000. However, it will be possible to operate systems at a capacity factor based on sales of 54.9 per cent to supply the 299,266,827,200 kw.-hr., producing a revenue of $7,211,817,484 annually. Under those conditions the ratio of capital investment to income will be reduced to 3 to 1 and the annual revenue per kilovolt-ampere of system capacity increased to $115.76.

Load Factor Possibilities

Load factor changes are valid measures of business values, for the larger the load factor the more the system investment is used and the less per unit of sales is the cost of a large part of the customer and operating charges. At the present time the national load factor is 34.2 per cent and, based on the survey, the available possible load factor is 76.8 per cent. In Table XII the class load factors are shown for present conditions and possible conditions. There is a possibility of more than doubling the present load factor on a national basis, and an analysis shows that the major possibilities of this increase lie in the cultivation of domestic business. This has possibilities of increasing from a value of 13.9 per cent to 22 per cent.

In Table XIII are presented the annual load factors of 21 of the largest utilities in this country and the change in their load factor from 1917 to 1925. A study of this table shows that load factor improvement, despite the growth of the industry, has been at a standstill. Twelve of the 21 utilities have a lower load factor in 1925 than they had in 1917, with a maximum decrease of 21 points for one utility. Only nine of the 21 utilities have an increased annual load factor, and the maximum increase for any of these was ten points.

In order to show how business increases on representative utility properties and how working day load factors have changed, the daily load curves for eighteen representative utilities are presented on pages 980 and 981. These load curves are for comparable days in 1920 and in 1924 for summer and winter conditions. The shaded area represents increase in business in the elapsed time as measured by daily winter load curves.

Table XIV gives a tabulation of the daily load curves and the changes. It will be noted that these working day load factors are good, that there has been little change in value in four years and that the values for working or week days must be very much higher than those obtained on Saturdays and Sundays if the annual load factors are as low as those given in Table XIII.

This means that residence business on Saturdays and Sundays on the basis of available possibility would fill valleys of the typical utility load curve appropriately.

A casual glance at the load curves on the graphs shows a wide variety of conditions to exist. Some properties have very high railway peaks, others have peaks at different hours of the day. Some have a decided shift in peak hours with a change in season, whereas others have a fairly uniform load curve throughout the year. Property *P* has a large system with a heavy night pumping load. Property *L* is a typical metropolitan system with a heavy railway peak in the evening. Property *M* shows a great gain in load, and it is interesting to note that it is an all-steam station generating property that serves its territory in competition with a municipal and a privately owned utility that depend upon hydro power. Property *O* has increased its business but little and shows a great degree of saturation in power service. In general, it is evident that any property not serving railway loads has a fairly uniform load during the day and cannot dwell heavily or accurately on "peak responsibility" in cost allocations. Likewise "peak responsibility" cost allocation would heavily penalize the railway business on those properties that serve railway loads. It is also noticeable that the noon dip is not at all prominent on most of the load curves and that the night hours offer the maximum possibility for load factor improvement.

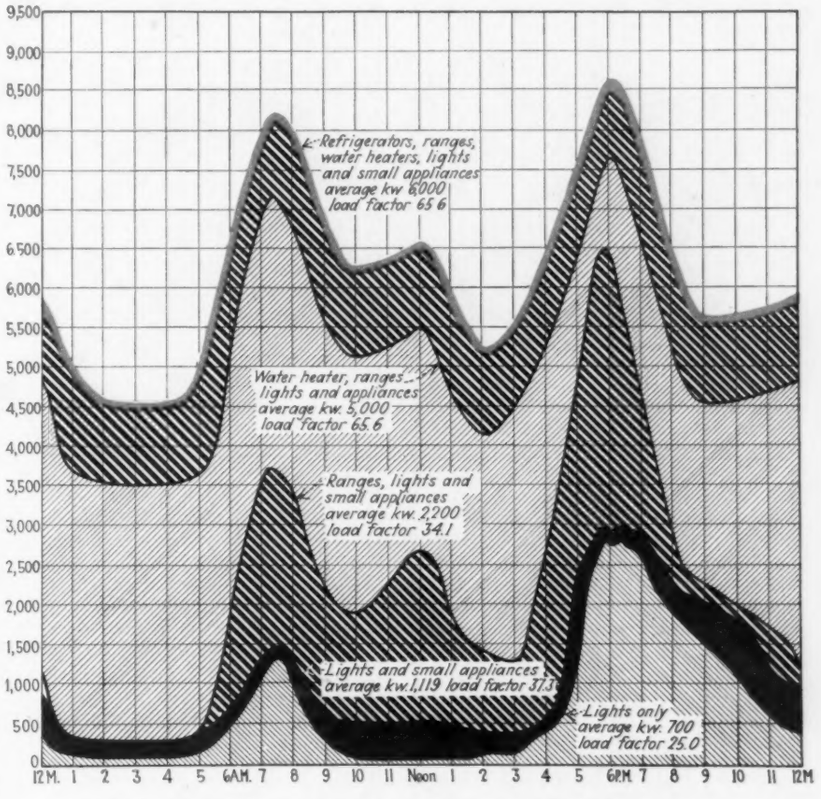


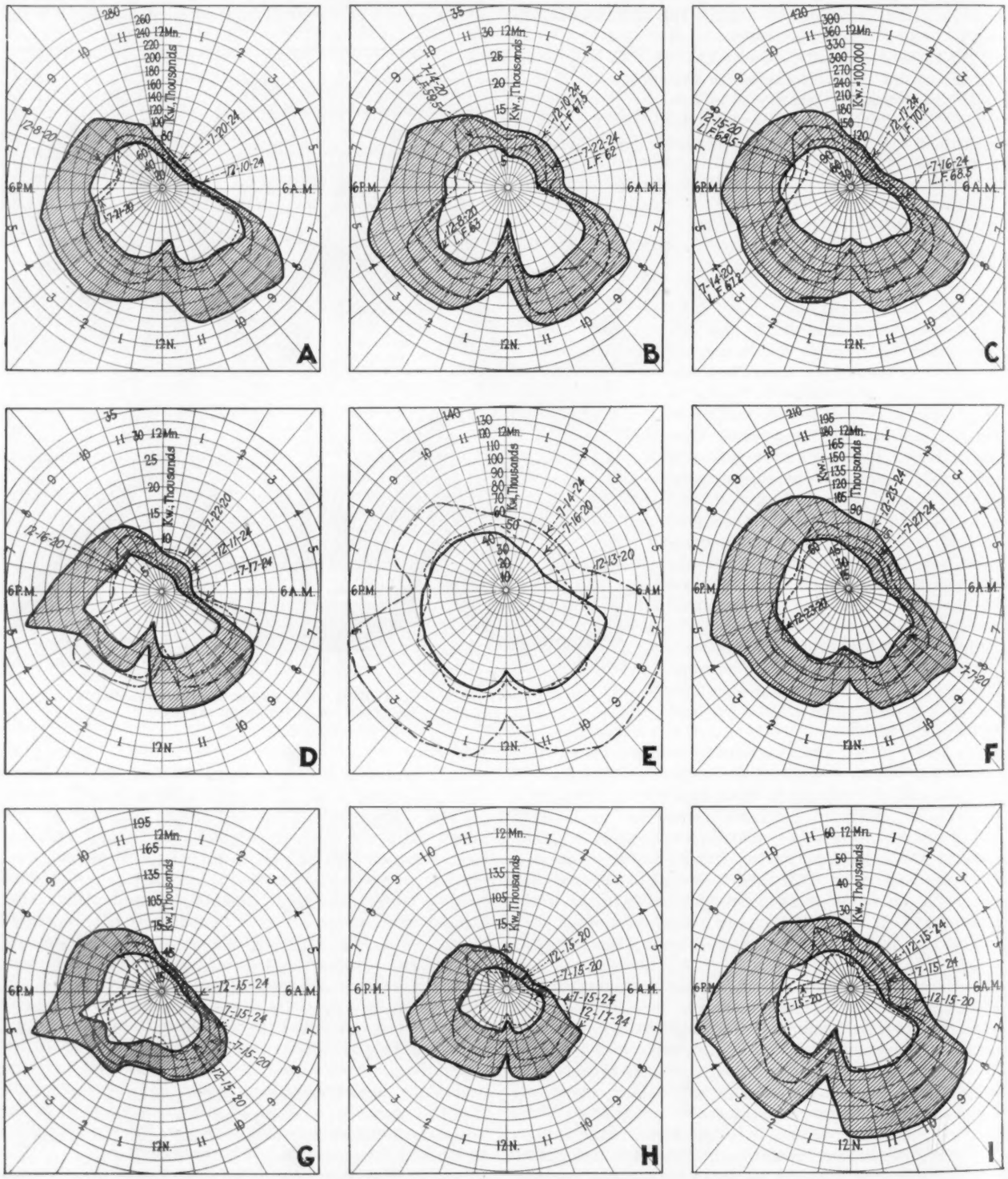
FIG. 7—RESIDENTIAL CUSTOMER LOAD UNDER AVAILABLE SERVICE CONDITIONS BASED ON SATURATION WITH 5,000 CUSTOMERS

In Fig. 2 is shown the present and available national load curves and the class load curves of the possible available business. An examination of this figure

shows the shape of the load curves to be changed but little on a national basis but that the amount of energy sold continuously during the 24 hours has increased largely. This can be brought about by taking advantage of the diversity in demands of the class businesses making up the composite curve. The domestic load and industrial heating load curves offer the greatest possibilities, but the battery-charging business and the railroad business are also influential elements. In Fig. 7 is given a typical change in the load curve of residence business based on developed business per customer on 5,000 residential customers.

The basic data were taken from a typical well-lighted and well-appliianced home and the load data on refrigerators, water heaters and ranges available from recent tests made by the N.E.L.A. commercial heating and cooking committee. This curve shows very remarkable possibilities for load factor improvement by intensifying domestic business.

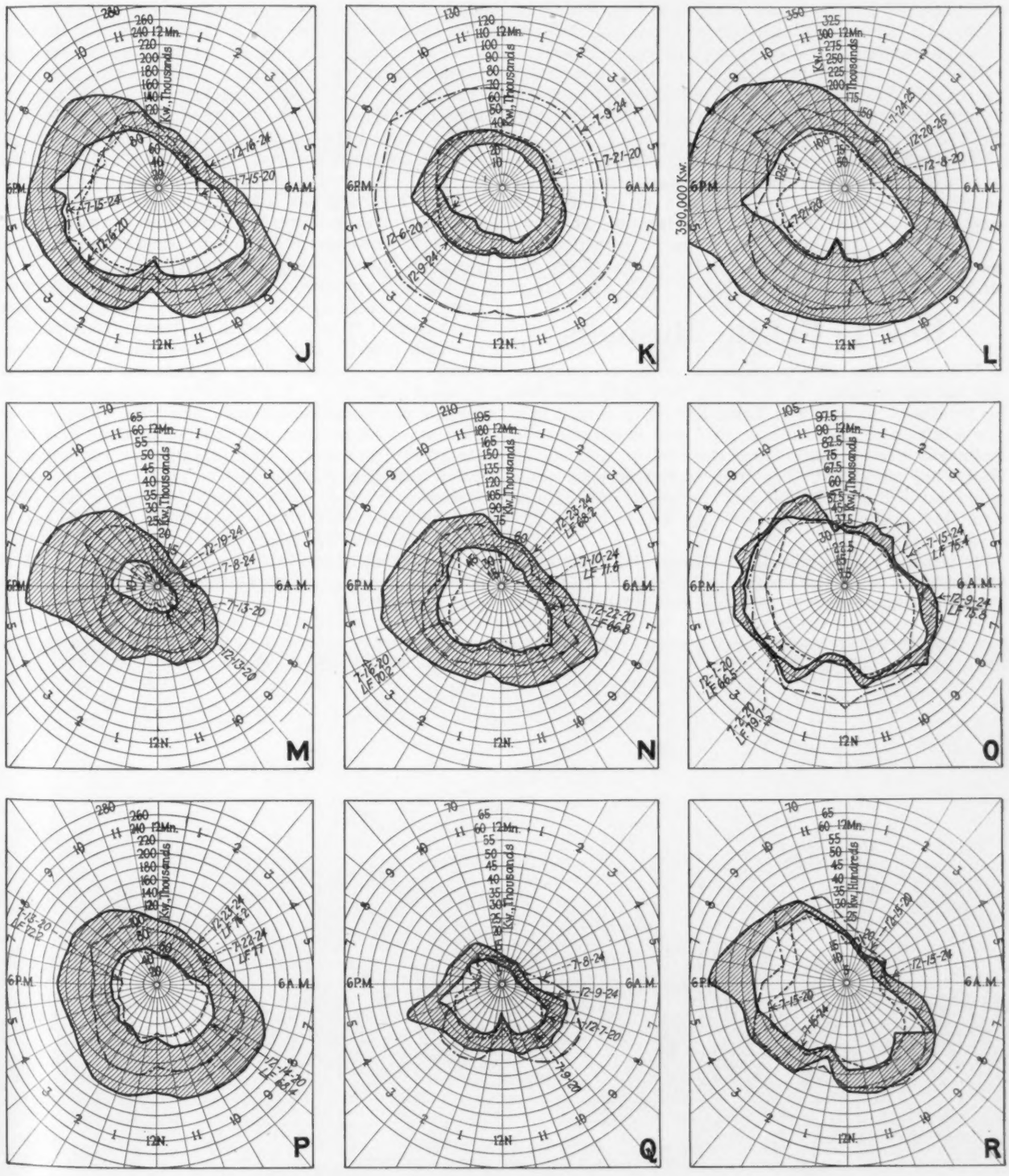
It will be noted from Table XII that the average



DAILY LOAD CURVES OF REPRESENTATIVE UTILITIES IN SUMMER AND WINTER, 1920 AND 1924.
SHADED AREA IS BETWEEN THE WINTER LOAD CURVES

rate per kilowatt-hour at present is 3.07 cents and that the average rate for the possible available business is 2.76 cents—a reduction in rate of 12 per cent, whereas the kilowatt-hours sold have increased 533 per cent.

This result was not expected in making the study and caused a great of interest. The industry has long recognized that consumption will increase and revenues will increase as rates decrease up to a certain point, but it was difficult to understand how such a slight rate decrease resulted in such a large increase in consumption. The answer lies in the study of the residence business in reference to the total business. The residence rate has been decreased 54 per cent and the consumption has increased 1,660 per cent, whereas the other rates are practically unchanged when measured in relative kilowatt-hour sales values. Thus residence sales increase far more rapidly than residence rates decrease; therefore residential revenues increase. Also even when halved, the residence rate is still the highest class rate and brings in 48.2 per cent of the revenue.



DAILY LOAD CURVES OF REPRESENTATIVE UTILITIES IN SUMMER AND WINTER, 1920 AND 1924.
SHADED AREA IS BETWEEN THE WINTER LOAD CURVES

This tabulation shows that cost allocations need not be made to check system economics as a whole, for many utilities desire to sell all their energy on the basis of an average price per kilowatt-hour. Fig. 6 shows a graphical presentation of the rate, sales and revenue changes for the different classes of business. Therefore, from the standpoint of average energy sales price, residence rates can be reduced very materially, if sales increase greatly, without causing any effects on net earnings per kilowatt-hour but those that are favorable.

But the item of fixed charges is also important in considering rates. Needless to say, a load factor change from 34.2 per cent to 76.8 per cent results in a very large proportionate deduction in fixed charges per unit of energy sold. This means it is possible to lower rates in greatest amount on those classes of business where load factor increases most rapidly with sales, provided the class investments are equal.

Thus when it is remembered that residence rates for available business were made at the start for each appliance in the home on the basis of a rate that would encourage use (see Table IX), the total result shown in Table XII is definite evidence that a rate that will get the residence business will be profitable for the utility.

How to Get the Business

With such enormous possibilities before the industry, the natural question is, How can this additional load be obtained? A glance at Table XII shows that it is in the addition of the domestic load and development of industrial electric heating that the greatest possibilities lie. Fully developed, these two classes of load would represent 48.2 and 17.5 per cent respectively of the total available revenue. At present they represent only 29.3 and 0.6 per cent.

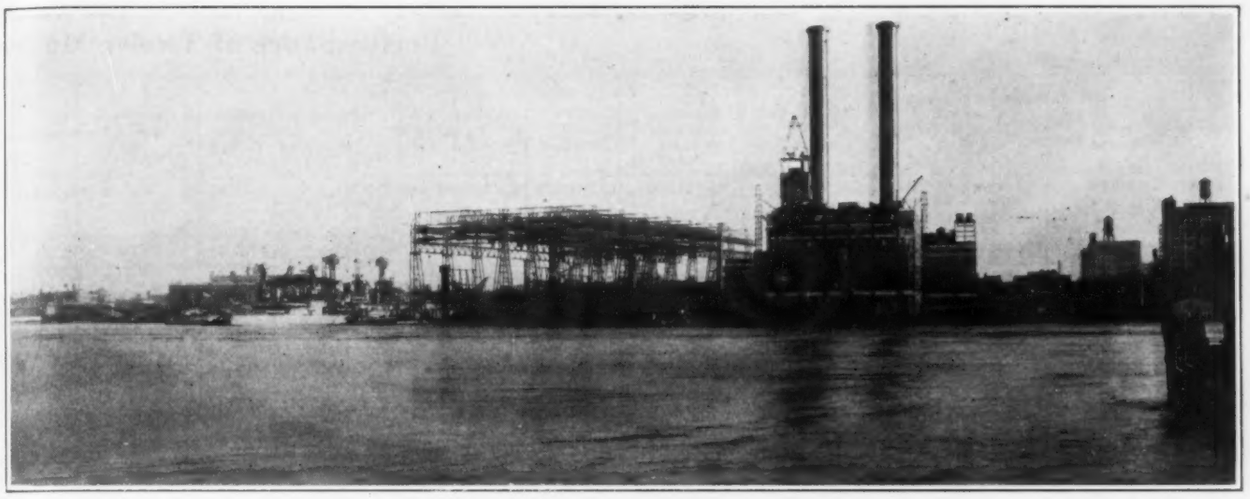
It is apparent much greater commercial effort must be put upon these two classes of business. With residential business only 7.3 per cent developed, industrial heating only 2.9 per cent and commercial cooking only 5.1 per cent, an entirely different conception is needed of the kind and quality of sales organization necessary to develop such markets. It is not meant that the industrial, lighting or any other class of business should in the least be neglected. But considered in the light of its percentage, the total available business sales effort on each class should be proportionate. In any event, commercial operation should be greatly increased.

In all probability normal growth would some time bring this load to the utilities, but the electrical industry has never been noted for complacency or an inclination to float with the tide. There are three elements that will govern the rapidity with which the available business can be taken on: Rate structures, sales organization and physical ability of the power companies to serve the load.

The last of the three is the least of the obstacles, for the industry has been and always will be "ready to serve." Rate structures, however, present a different problem involving not so much the question of greatly decreased average rates for service as a readjustment of the form of rate so that it will encourage greater use, particularly by the small customer.

It is in the central-station companies' sales organizations that the responsibility for the addition of new loads rests. It is a question of commercial facilities and man power. Equipped as they are now, the new-business departments cannot be expected to accomplish a superhuman task. But given the authority, financial backing and moral support commensurate with the work they have before them, the job can be done in a comparatively few years. A fivefold increase in revenue is worth spending some money to obtain and the great economies it would make possible in financial and physical operations will more than offset an increase in sales expense. The business is to be had—more than $7,000,000,000 worth of gross annual income. It is merely a question of how fast the industry is willing to travel to get it.

MUSCLE SHOALS STILL WAITS FOR A CONGRESSIONAL DISPOSITION



HUDSON AVENUE STATION OF THE BROOKLYN EDISON COMPANY

Experiences with Modern Stations

British Thermal Units per Net Kilowatt-Hour and Affecting Factors—Experiences with Different Methods of Firing, Steam Extraction, Reheating and Air Preheating

NO ONE FACTOR gives a true picture of the economy and satisfactoriness of generating stations. A thorough analysis must consider the combined operating, maintenance and fixed charges per kilowatt-hour for the present and ultimate plant, compared with local operating conditions and the experience with some of the relatively new applications. Until there is a great reduction in the tendency to misuse facts, there is not much hope of telling the complete story. Meanwhile the operating performance of some modern plants and their experiences with firing methods, steam extraction, reheating of steam and air preheaters may be of value.

FIRING METHODS

Very satisfactory reports have been obtained from operators on both pulverized fuel and stoker firing under adverse conditions without their concealing the fact that some problems remain to be worked out. Based on the progress made so far, the outlook for the solution of these problems is very promising. Despite the highly satisfactory experience with pulverized-fuel combustion, operating engineers contend that stokers are not a dead issue by any means, because competition between the two methods of firing are forcing developments in both that will make necessary a special investigation whenever a plant is considered to determine whether one or the other should be used.

The choice of firing method has been further complicated of late by the introduction in the powdered-fuel field of the unit or direct-firing system. Opinion on this development has not crystallized so far. One school of thought favors central coal preparation, although it believes that direct firing might be more economical for a small plant or for use in existing stations. The basis given for this belief is that larger coal-preparation units can be used with a central system and with less reserve, less total expense, less labor and with the reserve available to all furnaces.

The other school, inclining toward direct firing, believes that with direct firing: (1) *Reserve* can be provided with less investment than with the central system by having a portable unit to move into the place of a faulty unit, so there is no need of a separate reserve for each unit. (2) *Investment* in coal preparation is less, because units are compact and self-contained and do not require much space or a mill-house structure. Because the powdered coal is fed directly into the furnace, it is not necessary to dry the coal for transport reasons, the amount of drying depending more on the combustion requirements. (3) *Attendance* will be reduced for the total plant, because the boiler operators can serve as mill attendants; however, the boiler-room force may be increased slightly. (4) *Noise* will be considerably less, although the noise in the boiler room may be increased. (5) *Storage* in the boiler bins need not be greater than eight hours' usage, if the conveyors are made rugged and so constructed that they can be repaired in less than eight hours.

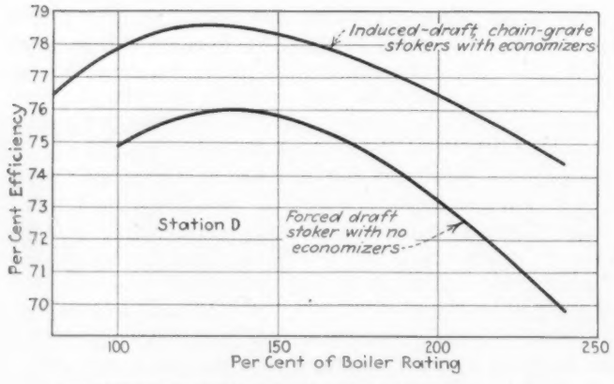
One operator, who has installed the direct-firing system in an existing station (K), declares that it was chosen largely because the physical arrangement of the equipment already operating was not suited to the application of a central pulverizing system without an unjustifiable cost.

Based on experience with the central system of pulverized-fuel combustion, station A declares that "experience has shown that just as high reliability can be obtained from pulverized-fuel operation as stoker firing, if the proper precautions are taken regarding the fine-

Performance of Twelve Modernly

Plant	Period Covered	Installed Generator Capacity, Main Units, Kw., Dec., 1925	Date Put in Operation	Total Kw.-Hr. Generated by Main Units	Net Kw.-Hr. Generated	Peak Load, Kw.	Plant[9] Use Factor, per Cent	Plant[10] Load Factor, per Cent	Fuel Consumption, Short Tons
A	1925	50,000 (7/31/24) 50,000 (9/18/24) 50,000 (1/12/25)	July 31, 1924	537,185,800	507,230,800	128,000	41.3	45.2[11]	305,086
	Dec., 1925	150,000 (see above)	July 31, 1924	.....	55,600,800	128,000	49.8	58.4	32,551
B	1925	80,000	Sept. 25, 1924	342,619,000	324,515,000	78,000	54.0	62	220,684
	Dec., 1925	80,000	Sept. 25, 1924	37,869,000	36,055,900	70,000	63.6	73	23,842
C[1]	April 6–9, 1926	90,000	Dec. 10, 1925	3,131,900	2,931,200	36,000	36.3	90.6	1,385.25
D	Dec., 1925	288,000	Original in Sept. 1, 1911	93,328,000	91,145,050	246,000	43.5	62.44	72,659
E[2]	Dec., 1925	145,000	Oct. 17, 1923	50,504,000	47,758,100	125,050	46.8[12]	54.2	37,679
F	Dec., 1925	20,000	Dec. 1, 1924	12,184,000	11,626,300	23,000 (hourly)	81.8	71.2	11,245
G[3]	June 2, 1925, to Jan. 1, 1926	35,000[3]	June 2, 1925	42,902,100	40,766,752	35,000	27.5	23.9	537,423,000 cu.ft. (natural gas) 6,618,741 bbl. of 42 gal. each (oil)
H[4]	Jan., 1926	85,000[4]	Nov. 29, 1924	58,462,400	56,669,480	88,200[4]	92.5[4]	89.2[4]	232,489,000 cu.ft. gas; 92,718 bbl. oil
I[5]	Feb., 1926	32,000	Nov. 1, 1925	10,240,204	9,879,670	33,500	49	43.9	Oil 8,545,000 lb.
J[6]	Dec., 1925	Three 22,500	April 18, 1924	16,670,000[5]	15,970,500	46,700	33.2	48	11,360
K[7]	Dec., 1925	122,000	Orig. 1904; Pulv. fuel March, 1925	14,031,400	13,262,140	48,000	15.46	39.3	18,074 for power generation, 15,3[illegible] for steam heating[7]
L[8]	March, 1926	2—30,000 kw. 1— 3,150 kw.	Jan. 17, 1925	21,564,000	21,443,629	34,325	45.9	84.4	10,931.86

[1]Reheating not in use at present.
[2]763,000 kw.-hr. of total reported was generated by house turbines, the 4,000 kw. capacity of which was not included in plant capacity of 145,000 kw.
[3]Net normal generator rating at 85 per cent power factor is 30,000 kw. and maximum net rating at 85 per cent power factor is 35,000 kw.
[4]The name plate ratings on the generators totals 75,600 kw.; considering this and the peak load of 88,200, the plant use factor is higher than the plant load factor. The ratio of gross kilowatt-hours to the product of name plate rating and turbine hours is 107.99 per cent.
[5]Station I did not operate over week ends; British thermal units per net kilowatt-hour during generating period of 506 hours were 14,760; station service, during generating period was 337,460 kw.-hr., and load factor 60.3 per cent. Total generated power includes (360,534) generated by 2,000-kw. auxiliary generator. Also 532,600 lb. of oil was used in standby service.



EFFICIENCIES OBTAINED WITH CHAIN-GRATE STOKERS (STATION D)

ness and moisture of the coal." "Excellent reliability" and "entire satisfaction" are reported by stations D and F respectively, the latter also declaring that "pulverized-fuel burning equipment has been found very flexible and permits the station to follow the load curve very easily and with minimum blowing of the safety valve."

Just as ardent commendation of stoker operation with poor coal is reported by other operating companies. Station B declares that "wall and tube slagging has been no more than could be expected with low-grade fuel and bad ash containing about 3.8 to 4 per cent sulphur and fusing at a temperature of about 2,100 deg. F. No trouble has been experienced due to the grates burning out." "Excellent reliability" is reported by station D, which adds that "few boilers are dropped from the line during load periods due to stoker failure."

Detailed Experiences with Powdered Fuel

Regarding powdered-fuel combustion, the most valuable comments center chiefly around the speed with which boilers can be brought up to or above rating, the efficiencies and percentages of nominal rating obtainable, unit labor and energy requirements for coal preparation and experiences with driers, mills, coal transport, powdered-fuel bins, coal feeders, furnaces and boilers.

Bringing Up Boilers.—During normal operation it is customary for station A to bring up powdered-fuel boilers from no load, but full steam pressure, to 230 per cent rating in five minutes. Loads can be increased from 200 to 300 per cent in regular practice in less than one minute. At station D, starting with a hot boiler, two minutes and 35 seconds was required to attain 50 per cent nominal rating after lighting the burners, three minutes and seven seconds for 100 per cent rating, and five minutes and 30 seconds for 305 per cent rating. This speed is considered the maximum safe rate of applying heat to the furnaces.

The limit to bring a cold boiler up to load is the amount of heat the brickwork can safely absorb; the incomplete combustion and consequent smoke caused by the cold brickwork is another limitation. The forcing

Equipped Steam Power Plants

Average B.t.u. per Lb. Fired	Average per Cent Ash	Fuel Cost per Short Ton Delivered	Fuel Cost per Million B.t.u.	B.t.u. per Net Kw.-Hr.	Steam Pressure at Throttle, Lb.	Steam Temperature, Deg. F.	Powdered Fuel	Stokers	Reheating of Steam	No. of Bleeding Points	Economizers	Air Preheating
13,660	7.2	$4.06	$0.1487	16,432	380	695	Yes	No	No	3	Yes	.....
13,520	7.2	$4.07	$0.150	15,830	380	695	Yes	No	No	3	Yes	.....
10,768	12.77	$2.15	$0.114	14,707	530	706	No	Yes	Yes	2	Yes	Half of furn. so equipped
10,796	11.56	$2.17	$0.10	14,251	530	706	No	Yes	Yes	2	Yes	Half of furn. so equipped
14,170	7.05	.....	.....	13,390	545	720	Yes	No	Yes[1]	3	Yes	Yes
12,764 (dry)	14.1	.....	.....	19,190	225 and 250	530 and 675	Yes	Yes	No	1	Yes	.....
10,830	13 (11 per cent moisture)	$3.09	$0.143	17,100	304	700	Yes	No	No	3	No	Two of the latest furnaces so equipped but not in operation during Dec.
9,436 (lignite)	4.5	$1.80	$0.095	18,253	369 (av.)	623 (av.)	Yes	No	No	3	....	Yes
235 B.t.u. per cu.ft. 8,935 B.t.u. per lb.	.....	Gas $0.20 per M.ft. Oil $1.20 per bbl.	$0.16 for gas, $0.15 for oil	16,250	370 (av.)	695 (av.)	No	Natural Gas and oil	No	4	....	Yes
,134 B.t.u. per cu.ft. (gas) 18,600 for oil	.....	.....	.....	14,933	375	700	No	Gas and oil	No	3	Yes	No
18,200	.....	$1.75 per bbl.	$0.286	15,720[5]	350	700	No	Oil	.....	....	....	.....
13,750	9.74	$5.67	$0.206	19,600	310	603	No	Yes[6]	.....	....	....	.....
10,778	13.4	$3.32	$0.153	29,377	190	513	Yes	Yes	No	No	Yes	No
14,065	6.60;S = 1.13 Moist. = 3.94	$5.04 in bunkers	$0.179	14,330	350[8] and 1,200	700	.....	Yes[8]	.....	....	....	.....

[4]Station J operates in conjunction with two hydro plants of 25,900 kw. capacity. Due to this the load factor of station J was only 48 per cent, although the system load factory was 54.8 per cent. For auxiliaries, 699,500 kw.-hr. were used. All auxiliaries except boiler feed pumps are motor driven. Stokers developed 258 per cent of nominal boiler rating continuously, and 300 per cent for four hours.

[7]Large portion of steam generated for district steam heating.

[8]A steam pressure of 350 lb. is used with 30,000-kw. unit and 1,200 lb. with 3,150-kw. unit; the 1,200-lb. outfit was not used enough to have material influence on performance; three 1,974-hp. boilers and one 1,573-hp. boiler used with stokers operated at 225 per cent rating. Auxiliary power was furnished chiefly (881,000) by two 2,000-kw. auxiliary generators on main shaft, and partly (120,371) by main units.

[9]Plant use factor = gross kw.-hr. generated by main units divided by (rating of main units × hours in period considered).

[10]Plant load factor = gross kw.-hr generated by main units divided by (peak load × hours in the period considered).

[11]Load factor was figured on basis of net kw.-hr.

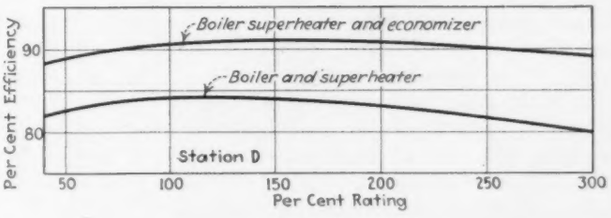
limit is also determined by the character of water and the rate of coal feed that will cause excessive wear of the transport system. Normally station A brings up a cold boiler to full load in two hours, whereas station F takes about four hours. Although it would not follow the practice regularly, station C has brought up a boiler from the cold condition to the steaming point (but producing no pressure) in five minutes. About ten minutes is required from this point to bring the boiler up to normal load.

Efficiencies and Ratings.—Test efficiencies of pulverized-fuel fired boilers at station D (see the accompanying curves) show a very uniform value between 50 per cent and 300 per cent nominal rating. Consequently there is very slight drop in efficiency due to operating with fluctuating loads. The limit to forcing the boilers is 300 per cent rating.

For the most part, the performance of the furnaces at station K has met all expectations, it is reported. The boiler and economizer efficiency has now attained 83 per cent and the maximum rating has become 325 per cent with very poor coal.

With the experience that has been obtained at station C it has been found possible to carry 300 per cent nominal boiler rating with nine vertical burners per boiler; with six horizontal feeders in use as well, 450 per cent rating can be carried.

A rating of 400 per cent was carried by station A for six weeks steadily fourteen hours per day. However, the company believes that 350 per cent is the maximum that can be carried safely continuously. It is



UNIFORM EFFICIENCY OVER WIDE RANGE OF LOAD WITH PULVERIZED FUEL, STATION D

impossible to operate the station efficiently below 180 per cent rating, because of the impossibility of cooling the walls without introducing too much excess air.

Considerable "tuning up" is still being done in the boiler room of station F. The boilers have been operated at 250 per cent nominal rating figured against the entire heating surface, or the equivalent of 330 per cent figured on the true boiler heating surface.

Energy for Coal Preparation.—This factor is not given on the same basis by all companies. For pulverizer-mill operation alone, station K reports approximately 15 kw.-hr. per ton, but attempts are being made to reduce this figure and increase the tonnage per mill. For coal unloading, preparation and transport to the boiler house, station F declares that 18.3 kw.-hr. was used per ton. A figure of 22.86 kw.-hr. per ton is given by station D for operating the pulverizer mills, exhausters and screw conveyors. For coal preparation and transport from bunkers to boiler bins, station A uses

22.95 kw.-hr. per ton, but attempts are being made to reduce this to 17 kw.-hr. per ton.

Labor.—The entire labor employed at station A for coal and ash handling was 0.213 man-hours per 1,000 kw. of station rating, compared with 0.117 man-hours per 1,000 kw. rating for a stoker-fired plant operated by the same company. Coal preparation alone required 0.127 man-hours per 1,000 kw. rating. Two attendants are employed to handle the fourteen six-ton mills.

Driers.—Apparent differences of opinion exist regarding the conditions under which driers are necessary. Station D reports that it does not dry the coal before or after pulverizing, because large daily shipments of coal provide enough dry fuel to supply the pulverized-fuel furnaces, any wet coal received being burned on stokers or stored. The moisture ranges from 2 to 8 per cent and averages 3 or 4 per cent. However, provision is made for waste heat driers if they ever become necessary. At a new plant being built by the same company steam driers will be installed, because all of the boilers will be fired with pulverized coal and the possibilities are that not enough dry coal will be received at all times to keep the boilers supplied.

Station F declares that driers are needed at certain times of the year. When driers are operating, it has been found possible to pulverize ten tons of coal per hour in each six-ton mill compared with only seven tons when the driers are out of service. This company favors steam-heated or separately fired driers.

To facilitate coal transport and avoid clogging of the valves and feeders, station A prefers to dry the coal so it will contain not more than 2 per cent surface moisture. It is possible to transport coal with 4 per cent surface moisture if the air is very dry, but, as will be pointed out later, 2 per cent seems to be the maximum practical limit. The driers, which are of the steam-heated counter-flow type, are able to handle about 25 tons per hour (maximum) with 1,120 sq.ft. heating surface. Their efficiency increases with the initial moisture in the coal. Every month all coal is drawn off the driers to prevent the accumulated dust oxidizing and catching fire. In shutting down its driers, station F shuts off the coal feed at the top of the driers, and the mills and driers are completely emptied to avoid any possibility of oxidation of the coal.

Driers are employed by station C, because it believes that thorough drying and pulverization are essential to satisfactory operation of the transport system and economical combustion, pulverized-coal-fired rotary driers being used.

LARGE MILLS IN DEMAND IF EQUALLY RELIABLE IN SERVICE

Mills.—The comment is quite general that if larger mills will give as good experience as the six-ton mills now used, they should be installed in the future, because not more than one man is required for every seven or eight mills regardless of the size. Six eight and one-half ton gear-driven screen-type pulverizer mills and one twenty-ton mill are used by station C. Both stations A and D, which use six-ton pulverizer mills, report that they stand up very well, the exhauster fans requiring the major maintenance. The blades of the fans used by station A have to be replaced after about 1,100 to 1,400 mill-hours (at 6.2 to 6.5 tons per hour) or after about 8,000 to 10,000 tons. Station D says that the blades can be replaced readily in an hour. Various materials have been tried to make the blades stand up longer, but station A is still relying on boiler-steel plate for replacing the blades in the spiders.

Experience with roll-type mills at station D has been very satisfactory, they being relatively quiet (a measure of vibration and consequent wear) and the maintenance not being high. In station A the mill rolls last about eighteen months at a pulverizer rate of 6.2 to 6.5 tons per hour before the company has to consider replacing them; the mill cases last about 50,000 tons. The plow tips that lift the coal in the process of pulverizing constitute a smaller item of maintenance. The fineness to which the coal is pulverized has been reduced from 60 per cent through a 200-mesh sieve to 43 per cent, but there is a question at present whether 43 per cent is too coarse. Station F reports that considerable dust still escapes from the cyclone vents and its deposit is rather objectionable.

DRY COAL EASILY TRANSPORTED

Coal Transport.—Very little trouble has been experienced with coal transport systems other than from wear of the exhauster fans and the sheet-steel piping, provided the surface moisture of the coal is held down, if sufficient air is injected to float the coal, if eddies are avoided and valves are properly operated, most of the companies report. There has been no apparent abrasion of the 8-in. standard wrought-iron coal transport pipes in station A in eighteen months' conveying coal at the rate of 85 tons per hour. If these pipes do wear through, most likely a patch will be welded on. Abrasion of the 22-in. sheet-iron pipe leading from the mills to the cyclone heads occurs chiefly near the outlets of the mills. Although it is not possible to say yet whether heavier or harder metal or both constitute the most economical solution of this problem, the thickness of the pipe is being increased from No. 14 gage to No. 10 gage, since the thinner pipe shows signs of wear after 25,000 tons of coal have passed through it at the rate of six tons per hour.

Occasional cleaning of the powdered-fuel screw conveyors is required, especially when moist coal is handled, declares station D. However, station A has found by experience that no trouble with clogging is experienced if the powdered-fuel conveyors are alternately operated and each conveyor is revolved at least five minutes per shift.

Air around the conveyors and cyclones may be kept at about 70 deg. F., contends station D, although this experience must not apply to other than the screw-feed type of coal transport. At station A the air is cooled after leaving the compressor, the moisture separated and the temperature raised before delivery to the transport system. This station has slightly increased the ratio of air to the amount of coal fed above that originally planned, but attempts are being made to reduce it. If the air is shut off, the coal transport lines tend to clog, the moisture content of the coal being the chief influencing factor, however. By keeping the surface moisture of the coal at 2 per cent or lower and keeping the coal in the transport line of motion, little trouble is experienced with clogging. Sticking of the valves in the transport and feed lines is avoided chiefly by operating them at least three times a day.

The power required to drive the coal transport pumps in station A has been increased from 60 hp. (originally considered sufficient for pumps operating at 85 tons per

hour, elevating the coal 100 ft. and pumping it 220 ft. on the level) to 100 hp. per pump.

Powdered-Fuel Bins.—With relatively dry powdered fuel, little trouble is experienced in the powdered-fuel bins if they are cleaned out periodically. Station D cleans its bins once every two months. Station A believes that the coal it uses can be kept in the bins two weeks without trouble due to oxidation providing iron pyrites are not present in large quantities, as experience has shown that fires never developed until after three weeks' storage with bunker vents open.

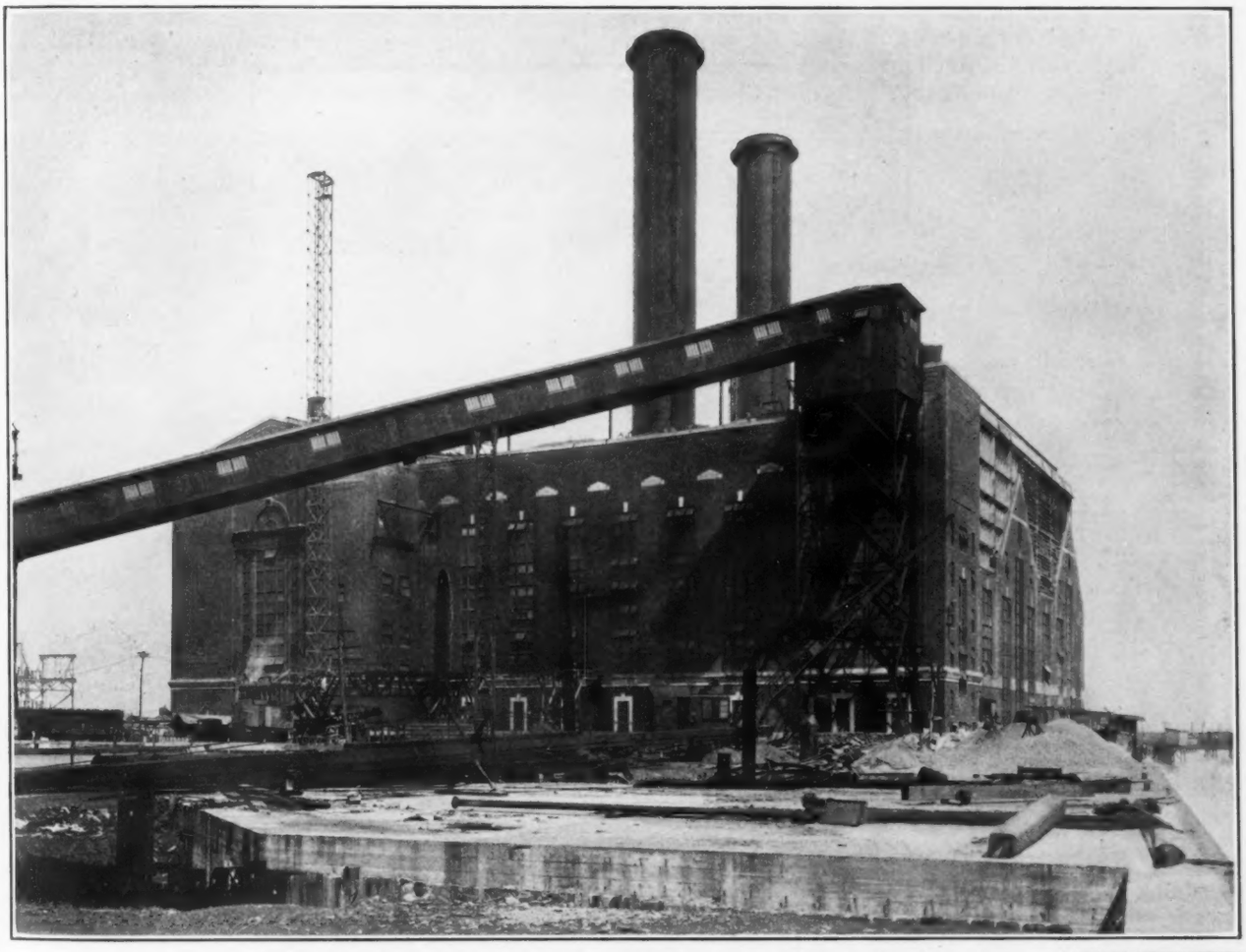
No trouble has been experienced with powdered-coal bins, according to station C, and no more than with stoker firing, according to station A. Depending on the moisture of the coal or air, condensation on the sides of uninsulated bins will occur when the outside temperature is very low and the station windows are open. With uninsulated bins and 2.1 per cent surface moisture in the coal, the coal has adhered to the walls and built up into a vertical or undershot wall, which will fall like an avalanche if agitated.

Station F reports that all of the piping of the air-separation system and the outside of the pulverized-coal bins has been covered with 2 in. of magnesia to reduce sweating on the inside of the bins. However, station A contends that there is a question whether a slight adherence of coal to the walls of the bins is not just as effective as insulating them if the bins are emptied every time a boiler is shut down to prevent fires.

The float-type limit switches used in the bins of station A to avoid overfilling have never failed in a year. By slight rearrangement of the paddle-type limit switches it is possible to avoid their sticking. Wet coal will plug up the vents and cause packing around the feeders unless agitated. For this purpose air is very effective. By operating the valves in the feed lines regularly, hindrance of action by the head of coal over them is prevented.

Feeders.—Various ideas exist regarding feeder drive and burner arrangements. For example, station A has sixteen coal feeders per furnace (each furnace having 25,140 cu.ft. of free volume between the tube screens and the first row of boiler tubes). From tests that have been made and considering the quality of coal burned at this plant, it appears that 1.7 lb. of coal can be burned safely per cubic foot of furnace volume per hour, giving a boiler rating of 400 per cent. Duplex feeders are used as a compromise between group and individual drive, no interconnection being provided between adjacent groups. The flexibility of control afforded by this arrangement is considered necessary, because the density of coal in the different feeders varies. At this plant and also at station D capscrews are inserted around the periphery of the feeder spirals 100 deg. apart, to break down any arches of coal that form.

On each end of each furnace in station D are eight burners with individual-drive coal feeders. Even with

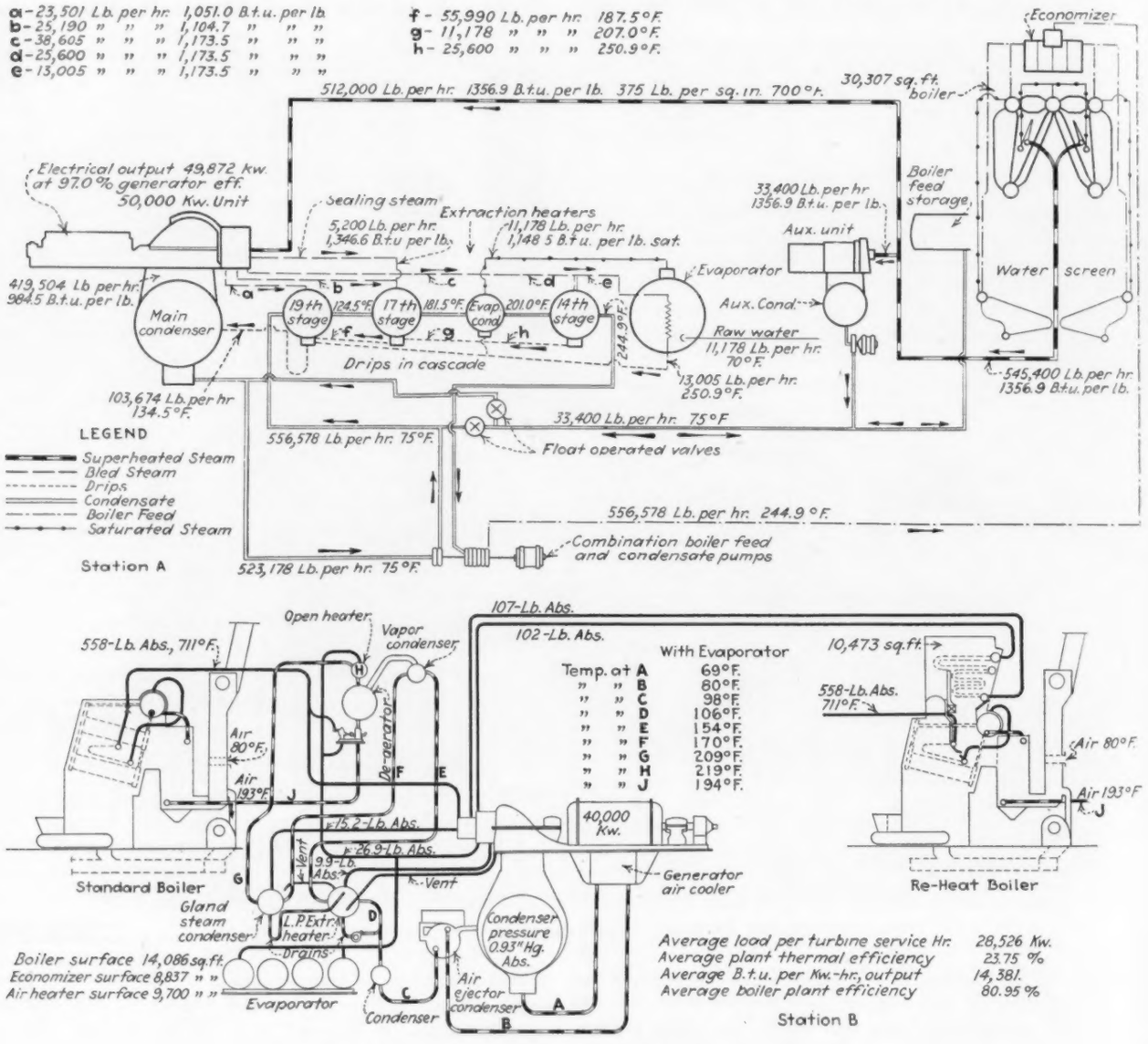


THE NEW KEARNY STATION OF THE PUBLIC SERVICE ELECTRIC & GAS COMPANY

clutch arrangements that are available it is not believed by the company that sufficient flexibility is obtained with group drives. The burners, which are of the corrugated fish-tail type, are inclined at about 10 deg. from the horizontal. They are preferred because they effectively spread the coal and consequently produce shorter flame length. Occasionally flickers at the burners are believed to be due to slugs of moist coal, it is reported.

Triplex feeders, of which there are five motor-driven sets to each furnace, are employed by station C for furnaces having a volume of 12,931 cu.ft. apiece. Nine vertical flare-type burners and six horizontal burners are used. However, station K, which installed one burner at the bottom of furnaces and two above, found that the lower burners did not permit the fuel from the upper burners to sweep down through the furnace sufficiently for complete combustion. Consequently the bottom burner is now omitted. These burners are tilted 20 deg. from the horizontal. It should be pointed out, however, that station K employs semi-turbulent combustion in its furnaces. It was found that too great turbulence resulted in losses, but of an entirely different nature from those with entire lack of turbulence as with a straight-shot burner.

Furnaces and Boilers.—It appears that furnace-wall deterioration can be kept within desirable limits by avoiding flame impingement, high CO_2 and excessive rates of heat application and by constructing the refractory walls to allow for expansion and contraction, protecting the walls with water screens or using water-cooled metal-faced furnaces. Slagging is minimized by maintaining the correct furnace temperature with relation to the ash-fusion temperature and is protected against by water screens and wall protection where the nature of the coal demands it. The rate at which coal can be fired is not limited by the mechanical apparatus but by the rate at which heat can be absorbed by the furnace walls and the temperature at which excessive slagging occurs. Practically no precautions are necessary to prevent burning of boiler tubes other than what is good practice for operating any boilers. Owing to



METHOD OF USING STEAM EXTRACTION AT STATIONS A AND B
(Reheating of steam also used at Station B)

the large cost of large-volume combustion chambers, considerable attention is being given to means of creating more turbulent combustion and thus assuring complete combustion with smaller furnace volume. Apparently there is a limit beyond which turbulence of combustion can be carried with beneficial effect on furnace performance.

Erosion of Furnace Walls

Some erosion of the furnace walls in station A has occurred, but there is a question whether it is due to flame impingement or zones of high CO_2. The furnaces, which have tube screens across the hearth, are operated normally to give 230 to 250 per cent of nominal boiler rating. The average temperature of the furnace is 2,400 deg. and the fusing temperature of the ash is 2,100 to 2,600 deg. F. The chief brick trouble is due to spalling and lever action. Experiments are being made with different kinds of furnace-wall construction to allow for the expansion necessary. No trouble from clinker formation and wall deterioration have been experienced by station D, as it operates chiefly around 200 per cent rating. The average rating of the pulverized-fuel equipment in pounds of fuel per hour is 74,800 and the minimum is 130,000.

Effect of Water Screens

The water-screen boiler tubes protecting the furnace hearth of station A cause the ash to deposit in granular form like sand that can be easily sluiced away hydraulically, although some clinkers pass through which clog the sluice and must be removed. At station F the firemen are very careful not to let the flames pass through the water screen and to maintain as even combustion as possible.

For protection of refractory walls, water screens in addition to wall ventilation has possibilities, declares station A. However, the advisability of using cast-iron walls is chiefly an economic problem and a question of how often they will have to be replaced.

Softening and Melting Temperatures of Furnace Brick and Coal Ash

(Station D)

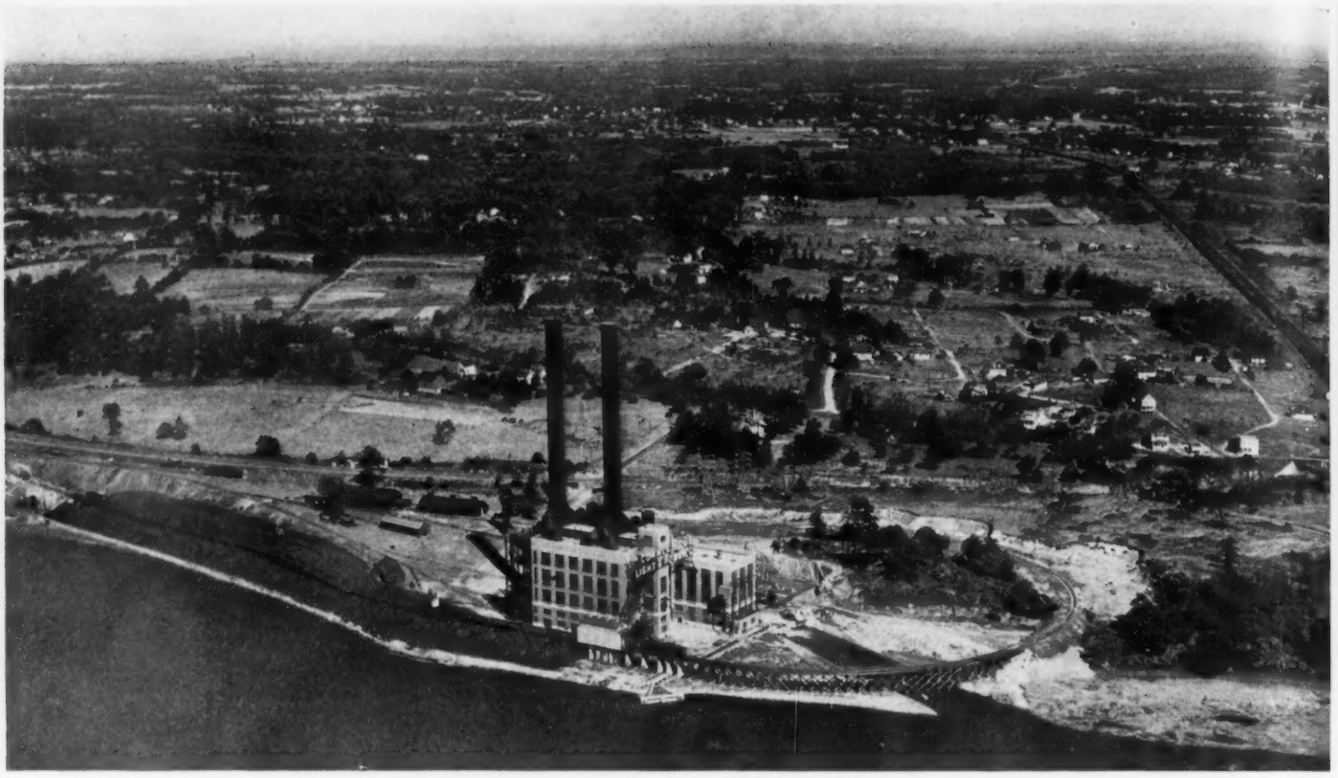
Material	Softening Point, Deg. F.	Melting Point, Deg. F.
Plaster coating	2,598	2,640
Brick	2,585	2,650
Coal ash	2,016	2,147

No trouble has been experienced with burning of boiler tubes at station A, but the station had some trouble with the water-screen boilers due to scaling at high ratings (1,100 to 1,200 per cent) caused by poor water or poor distribution thereof. This trouble was corrected. Considerable formation of clinkers on the boiler tubes of station F has been experienced, which gradually fills up the spaces between the tubes. To remove them an air lance is used quite effectively once each day on the front row of tubes on all active boilers. Some blistering was experienced on the upper half of the water-screen tubes prior to their being covered with a tile similar to the C-tile used for baffling Heine boilers. At station A slight slagging has occurred on the boiler tubes exposed to the fire and at the entrance to the first pass and steam and air lances have been used to remove it, but all of the tubes cannot be reached from the hand holes while the boilers are in service.

A WEST COAST HYDRO-ELECTRIC STATION—PIT RIVER NO. 3 PLANT OF THE PACIFIC GAS & ELECTRIC COMPANY IS THE LATEST ADDITION TO THE PIT RIVER DEVELOPMENT

Circular Combustion Chamber Advocated

No trouble has been experienced with clinker formation or brickwork trouble at station C, but this station has not been in operation long. In addition to the rectangular cross-section powdered-fuel furnaces, there is one circular furnace, designed for semi-turbulent



Devon Station of the Connecticut Light & Power Company

Two Large Steam Stations for the Supply of Transmission Systems

Philo Station of the Ohio Power Company

combustion, which is 18 ft. in diameter and the same height as the other furnaces. The circular furnace, with tangential coal feeds, keeps the flames from impinging on the furnace walls, and the secondary inlets between coal feeds permit better mixing of the air and coal. If all the furnaces in the plant were of the circular construction, the company believes that the construction costs would be lower than for the customary rectangular furnace using less turbulent combustion.

Experience with Turbulent Combustion

Probably the most extensive experiences with semi-turbulent combustion have been had by the company operating station K, where unit pulverizers are applied. About 0.575 cu.ft. of furnace volume was employed per square foot of steam-making surface. To effect complete combustion a new type of burner was employed which supplies with the coal 50 to 80 per cent of the air required for combustion, the remainder being admitted through deflection vanes around the fuel nozzles in the furnace.

In view of the unsatisfactory experience which this company had with air-cooled walls at station E, water-cooled walls were used at station K to permit sustained high rates of combustion without damage. Precast refractory-faced cast-iron blocks replaced the usual furnace brickwork, excepting on the front and rear walls. A refractory composed of alundum and fireclay was found most desirable. Bare cast-iron blocks were used on the lower section of the furnace to prevent slag formation during operations.

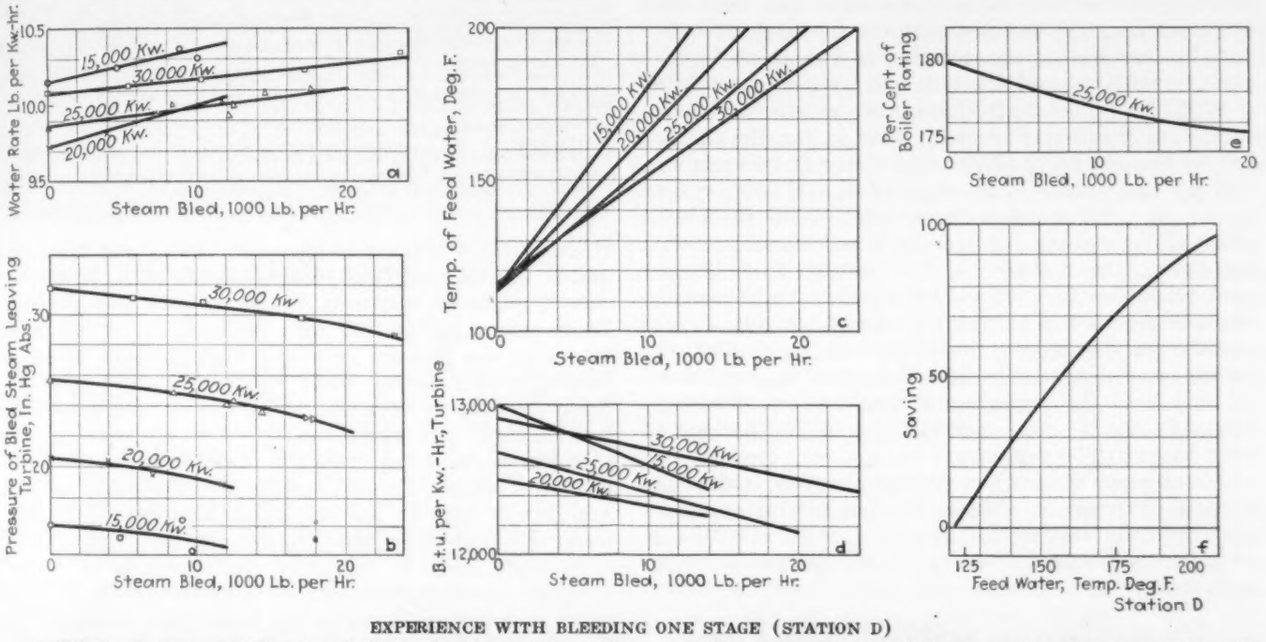
With this construction it is possible to operate at rates in excess of 300 per cent continuously without the formation of molten slag or injury to the furnace walls. With water-cooled walls there is a reduction of about 6 per cent in the temperature of the steam leaving the boiler, so the convection-type superheater was supplemented by a radiant superheater on the rear wall of the furnace.

Stoker Experiences Outlined

As previously mentioned, wall and tube slagging have been no more than could be expected with low-grade fuel and bad ash at station B. The refractory walls are not protected, but it is planned to protect them in an extension to the station, although it is not decided whether water screens or cast-iron faced furnace walls will be used. The forced-blast chain-grate stokers employed are normally operated at 225 to 250 per cent of nominal boiler rating, although they have been forced to 400 per cent, giving a maximum furnace temperature of 2,800 deg. F., depending on the excess air present. About 1 to 1¼ per cent of the coal is lost in the ash on the average.

Based on the total possible boiler hours in December, the boilers (including reheat boilers) of station B were in service or available for service five-sixths of the time. Reheat boilers were available for service seven-eighths of the time, but these boilers are not subjected to as severe combustion ratings as the standard boilers. In general, the maintenance, operation and service continuity of the reheat boilers is as favorable as that of the standard boiler. Attention to furnace walls constituted the chief cause for outage of the boilers. The side walls of the furnaces are slagged during operation, but the back walls have to be cleaned when the furnace is out of service. Boiler tubes, superheaters, stokers, economizers, air preheaters, fans, valves and joints are minor causes of outage, considered individually. With full load on a main unit, three of the four boilers per group can carry the load. In eighteen months it has never been necessary to clean the boilers. Ash-sluice pump rotors last about four months. When the casings wear out, they are built up by welding.

Although no more tube slagging is experienced at station B than would be expected with the grade of coal and ash used, it is serious enough to cause reduction of output if allowed to collect until the boilers are shut down. By inserting a hand lance under 50 lb. water



EXPERIENCE WITH BLEEDING ONE STAGE (STATION D)

a—Effect of steam bleeding on turbine water rate (superheat 250 deg. F.); *b*—effect of increasing steam bled on pressure of bled steam; *c*—effect of bleeding on feed-water temperature; *d*—effect of bleeding on British thermal units per kilowatt-hour chargeable to turbine unit alone; *e*—effect of bleeding on boiler ratings; *f*—financial saving (in abstract units) with changes in feed-water temperature from bleeding one stage (fixed charges were assumed at 15 per cent).

pressure and with a ¼ or ⅛-in. nozzle through the hand holes just below the front of the lowest boiler tubes (B. & W.), it is possible to remove the slag on the tubes while they are in service. No tube trouble has been experienced as a result of this practice. Slagging of the boiler tubes is scheduled by shifts, the boiler-room foreman determining by observation which boilers require slagging.

No more precautions are observed in station D to prevent clinker formation and brick deterioration and burning of tubes than are commonly observed in good boiler practice. At this station, where individual stokers have an average rating of 275,000 and a maximum rating of 460,000 lb. of fuel per hour, the company has limited the rating of the boilers to 275 per cent. The efficiencies of the two types of stokers used in this station are shown for loads ranging from 75 to 240 per cent nominal boiler rating. At the loads normally carried, fluctuations in load decrease the fixed load efficiency about 1½ per cent with the forced-draft stoker installations having no economizers and about 2½ to 3 per cent with induced draft stokers having economizers.

With the forced-draft chain-grate stoker installation at station D and starting with a hot boiler, the furnace can be brought up to 50 per cent rating in two minutes, 100 per cent rating in three minutes, and 250 per cent rating in eight minutes 50 seconds. With the chain-grate stoker having induced draft and starting with a hot boiler, the furnace can be brought up to 50 per cent rating in six minutes, 100 per cent in 11 minutes and 250 per cent in sixteen minutes 40 seconds. These speeds are considered the maximum safe speeds at which to raise the load under the operating conditions. At station J the underfeed stokers are operated continuously at 258 per cent rating and for periods of four hours at 300 per cent.

About 4 per cent of the generated power is used for station purposes at station B when operating at 78 per cent daily use factor. At station D about 0.0194 lb. of steam is required to drive the stokers per pound of coal fired.

Experience with Main Unit Bleeding

Various numbers of bleed points and ways of using extraction heating are employed by the companies investigated, the number of steam extraction points ranging from one to four, but apparently favoring three. Some extraction-heating installations are inherently automatic and others have hand control, the feed-water temperature being allowed to fluctuate with the load in the first type and maintained uniform in the second type.

The effect of bleeding under operating conditions has been exhaustively studied by station D, which bleeds only one stage with hand control. Accompanying curves show the effect of different unit loads and amounts of steam bled on water rates, bleeder pressure, feed-water temperature, British thermal units per kilowatt-hour, boiler rating, etc.

Station B bleeds two stages; stations A, C, E (on latest turbine), F and H three points, and station G four points. An economic balance based on the load, duty and probable service hours should determine the number of bleed points.

Two-Stage Bleeding.—At station B, the twelfth and sixteenth stages of the turbines are bled, hand control being employed. To secure the greatest station economy, all the extraction possible is taken from the sixteenth stage and the deficit made up from the twelfth stage. With full unit loads, there is more bleeding capacity than is necessary to maintain the desired feed-water temperature. No trouble has been experienced with this equipment. The company has not considered it advisable to have more than three bleeders (only two are installed) because of the added investment, attention, complications of the turbine barrel, etc.

Three-Stage Bleeding.—At station C steam is bled from the eighteenth, twenty-second and twenty-fourth stages. No attention is necessary with load changes unless the load per unit drops considerably, in which case it might be necessary to shut off the last bleeder. When operating at full load without extraction and returning the leakage from the high-pressure packing to the twenty-second stage shell, the water rate of these turbines is expected to be 7.67 lb. per kilowatt-hour, according to guarantee.

Table I—Effect of Fractional Load on Feed-Water Temperature

	Load on Main Unit— ¼	½	Full
Fourteenth Stage			
Bleed pressure, lb. abs	18.2	23.4	34.9
Bleed temperature (deg. F.)	220	236	239
Feed temperature (deg. F.)	209	225	237
Seventeenth Stage			
Bleed pressure (lb. abs)	5.8	7.1	10.5
Bleed temperature (deg. F.)	169	178	195
Feed temperature (deg. F.)	153	166	182
Nineteenth Stage			
Bleed pressure (lb. abs.)	2	2.4	3.
Bleed temperature (deg. F.)	126	133	146
Feed temperature (deg. F.)	105	114	126

Note—No attempt made to keep feed temperature uniform.

Steam is extracted from the fourteenth, seventeenth and nineteenth stages at station A. The bleed points are always open to the extraction heaters. With low loads the feed-water temperature reduces slightly and with high loads it increases, but there is a range through which the temperature is fairly uniform. The effect of fractional load on the feed-water temperature is indicated in Table I.

With the most efficient load on the main unit (40,000 kw.) the water rate is increased 6½ per cent by bleeding, but the coal consumption per kilowatt-hour will be only 96.3 per cent of the non-bleeding consumption.

Steam is bled at 2 lb., 15 lb. and 55 lb. absolute pressure at station F. The amount of steam bled at the lowest and highest pressures is determined entirely by the load on the turbine and the amount of condensate passing through the heater. The amount of steam bled at atmospheric pressure is rather small and is controlled by thermostats, so that the temperature of the water leaving the deaërator will always be 206 deg.

The eleventh, fifteenth and eighteenth stages of the main turbine are bled at station H, the pressures and temperatures at the bleed points for maximum load being indicated as shown in Tables II and III.

Table II—Stage Bleeding Pressures and Temperatures (Maximum Load) at Station H

Stage Bled	Steam Pressure	Steam Temperature, (Deg. F.)
Eleventh	60 lb. gage	305
Fifteenth	2.5 lb. gage	220
Eighteenth	3 lb. (abs.)	140

Fifteenth stage bleed steam is used for evaporator and de-aërator heater

Table III—Effect of Bleeding on Turbine Water Rate and Turbine Cycle Economy at Station H (Actual Test)

	Turbine Water Rate, Lb. per Kw.-Hr.		Turbine-Cycle, Ecoomy B.t.u. per Kw.-Hr.	
Load, Kw.	Without Extraction	With Extraction	Without Extraction	With Extraction
33,000	9.2	9.8	11,730	10,900
40,000	9.65	10.1	11,900	11,050

Under the best operating conditions the saving effected by extraction heating is about 7½ per cent. No serious operating diffculties have been encountered due to extraction under fluctuating load.

At station E, stage bleeding is used at three points on the latest turbine—namely, 66 lb. absolute and 110 deg. superheat, 18 lb. absolute saturated and 5 lb. absolute, 95 per cent quality.

Four-Stage Bleeding.—Four bleed points are used by station G, the pressures being as indicated in Table IV.

On light loads the water is cut off the low-pressure heater to prevent refrigeration. Otherwise no changes are made under varying loads. Based on a load of 22,500 kw., it is estimated that 1,140 b.t.u. per kilowatt-hour is saved due to stage bleeding. This is approximately 7 per cent.

Steam Reheating and Air Preheating

Reheating of steam between the high and low pressure elements of turbines has been used so far only in stations operating at pressures in the vicinity of 600 lb. or higher, to assure dry steam through the low-pressure stages and thus reduce blade erosion. However, due to operating problems that are not reflected in the experiences related herewith, some designers and users are now considering the omission of reheating in 600-lb. plants for that part of the equipment that does not operate at a high capacity factor and that is subject to fairly frequent starting and stopping. It can be applied successfully to base-load stations on power systems where the full use of the plant equipment can be had the greater part of the time.

Stations B and C reheat their steam, the first station between the seventh and eighth stages and the second station between the fourteenth and fifteenth stages. In station B the reheat boilers are operated to maintain the desired reheat temperature to the low-pressure stages of the turbine. If the turbine overspeeds, a trip closes the throttles on both the high and low pressure sections—the latter to prevent additional overspeeding from sudden expansion of the steam stored in the reheat boilers. Overspeed tripping also slows down the induced-draft fans on the reheat boilers, cuts out the forced-draft fans and opens the ventilators on the furnace. No large changes in the reheat temperature have been experienced with fluctuations in load even without furnace adjustment. No automatic provision is made to control the reheat temperature when the load drops or fluctuates, hand control being considered adequate and no hardship. The net benefit of reheating

Table IV—Pressures at Four Bleed Points (Lb.) at Station G

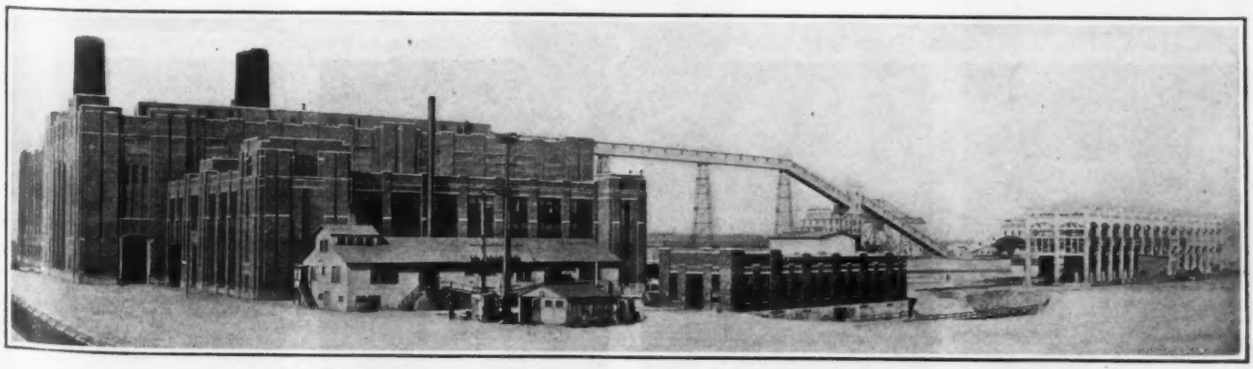
Kw. Load	First	Second	Third	Fourth
31,250	170	58	14.55	3.67
22,500	121.1	41.5	10.46	2.66
15,000	85.1	29.4	7.43	1.91

the steam to the lower stages has been approximately 4 per cent over the entire range of load, according to this company; besides, the erosion of turbine blading from wet steam is largely eliminated.

At station C it is planned to keep the load uniform on the main unit and the reheat temperature will be maintained by hand control of the reheat furnace. Although automatic features are not favored at the present time, provision has been made so that if the unit loses its entire load, the coal feed to the reheat furnace can be automatically shut off and the furnace vents opened. As in station B, it has been found that the reheat temperature does not fluctuate considerably with changes in load and that hand control is adequate to take care of any operating conditions.

Besides reducing the flue-gas losses, air preheaters so improve combustion that the actual gain is considerably greater than the saving in flue-gas losses. Apparently chain-grate stokers burning the poorer grades of coal may be expected to show a greater gain from the use of preheated air at a given temperature than can underfeed stokers burning a very good grade of coal with air at the same temperature.

At station B, where forced-draft chain-grate stokers are used to burn very poor coal, the air preheaters, which are of the plate type, have been so effective for the price installed that plans are being made to install air preheaters on the second group of boilers, which were not so equipped originally. The preheaters reduce the economizer gas-outlet temperatures 65 to 110 deg. depending on the load conditions. No corrosion of the plates in the air preheaters results if the boiler load is not allowed to drop so low that the stack temperature is reduced to the point where dew forms on the plate.



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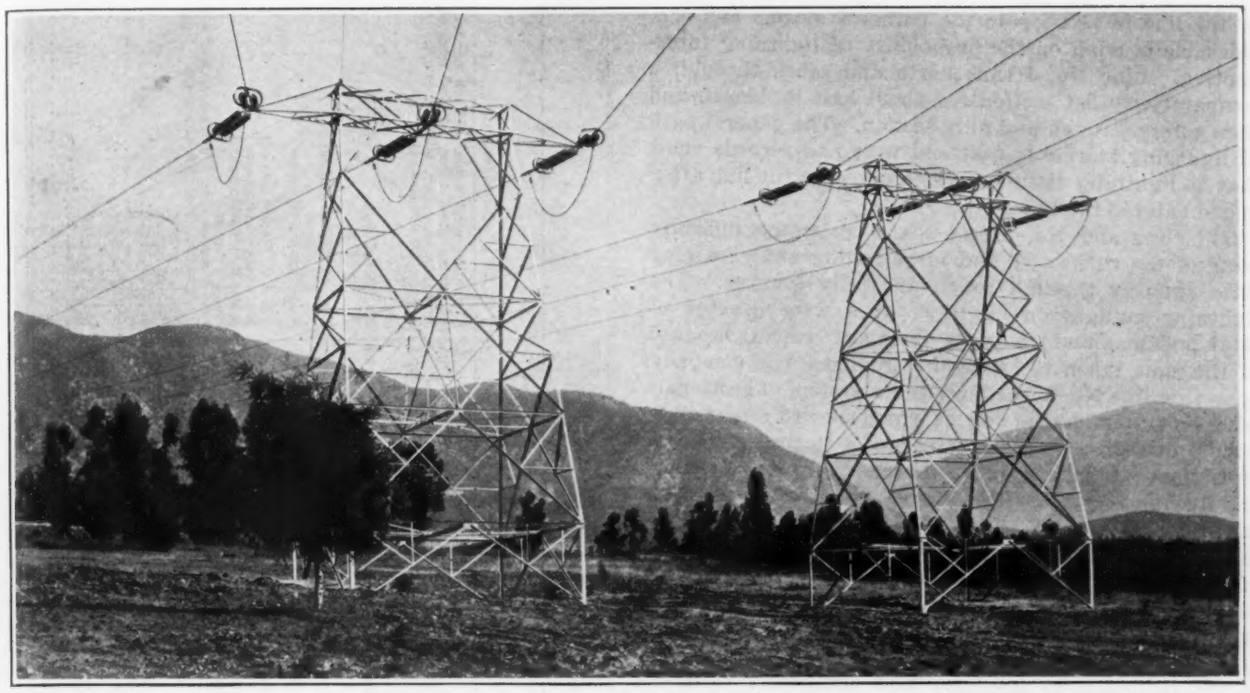


THE 220-KV. BIG CREEK TRANSMISSION LINE OF THE SOUTHERN CALIFORNIA EDISON COMPANY

Reliability of Transmission Lines

Interruption Records on Twenty Lines in Different Sections of the Country Show Decrease in Number and Duration of Failures—Measures Being Taken to Increase Further the Reliability of Service to the Customer

THIS article and the accompanying table and charts are the results of an investigation made from the line service records of several companies operating transmission line systems in different parts of the country. With the increasing industrial and domestic use of electricity the building of large steam-generating stations at load centers presents increasing economic difficulties, and the growing demand for energy is requiring the development of all possible water power and the location of steam plants at comparatively remote points. The reliability of high-voltage transmission lines is thus becoming more and more of vital importance in rendering service to central-station customers. No direct comparison of reliability was possible or attempted, because of the widely varying operating conditions, but some general deductions may be made from the combined records of the twenty lines included in the survey.

In general, transmission reliability is improving and interruptions to service are decreasing in both numbers and magnitude. The effort being devoted to careful analysis of all failures, with resulting corrective measures, indicates, however, that most companies feel that a great improvement is still possible and that nothing short of 100 per cent service is the goal to be attained. Corrective measures have further developed into preventive measures, so that many weak points that might cause serious failures are found as a result of analysis of previous trouble.

The number of interruptions charged to lightning formed a generally large percentage of the total number of interruptions, but in time duration they were comparatively small both in actual length and in percentage of the total interruption. During the year 1925, for which there are complete records of number and duration of interruption on the first seventeen lines of the table, there was a total of 270 failures, of which 148 (54.8 per cent) were due to lightning with a total duration of 12,166.8 minutes, 6,513.5 minutes of which was due to lightning. The interruption of 4,486 minutes on line No. 4 was due to the difficulty of patrolling this line, and if this duration is deducted, the total interruption on the sixteen lines was 7,680.8 minutes, of which 2,027.5 minutes, or 26.4 per cent, was chargeable to lightning. Lines Nos. 1 and 2 were located in a district that is not particularly subject to heavy lightning storms, but all the remainder of the lines have certain seasons of the year in which a number of thunder and lightning storms may be expected.

July, August, June, April and May are the months in which most of the lightning disturbances occur, according to the number of interruptions recorded in each month. A majority of interruptions took place in the middle of the afternoon, a large number between midnight and 5 a.m. and very few during the remainder of the day.

It was noticed on several lines that the nature of the country through which the line runs and the direction

of the line in relation to the paths of storms had considerable bearing on the probability of lightning interruption. Line No. 4 runs north and south through a comparatively flat section for about half its length and then enters a rough and hilly section. The general path of lightning storms is east and west and records show that all lightning disturbances occurred on the line after it had entered the hills.

This line and No. 3 and No. 8 show the difficulty some of the companies find in patrolling and repairing lines running through rough and hilly country. The lightning outages on all these lines were greater in total and maximum outages than any others, because of the time taken to locate the trouble. The company operating line No. 3 has developed a system of sectionalizing its system during storms which showed remarkable results in 1925. On the approach of a storm the load is apportioned to plants in various parts of the system, and lines in the path of the storm are as far as possible taken out of service. Line No. 3 was ordered out in this way eleven times in 1925, with a total time duration of 3,073 minutes, and the failures to the line with consequent disturbance of the system were reduced from 930 minutes in 1924 to five minutes in 1925.

One noteworthy feature of lightning interruptions is the reduction in insulator and equipment failures directly chargeable to lightning. In earlier years this was frequently a cause of prolonged interruption, but regular testing of insulators by some approved method, checking of relays and inspections of equipment are reducing the number of weak points on the line that will give way at the first disturbance.

Effect of Increased Line Insulation

Three of the lines that are heavily insulated in proportion to their rated voltage, Nos. 5, 7 and 12, have small total and maximum outages due to lightning. No definite comparisons can be made, but line No. 6, with the same operating voltage but an insulated voltage of 132,000 volts against the 200,000 volts insulation of No. 7, has a much greater record of lightning interruption for the years 1922 to 1925. Studies are being made in various localities on the use of various protective devices to lessen the effects of lightning surges. One company finds that most of the damage with suspension-type insulators occurs either to the top unit of the string or to the lower insulator pin and the conductor at the clamp. This company has also determined that practically all trouble is on the top phase of conductors in vertical alignment and is considering the installation of overhead ground wires on existing and future lines. One company, operating line No. 4, installed a ground wire in the fall of 1925 and has had no failures since in spite of several severe lightning storms. Various types of rings and horns are also being tried out and experience to date indicates a very positive value for them. A company with arcing horns installed on a section of line found the horns showing signs of a heavy arc but with the insulators in good shape and no record of disturbance on the line. Lightning arresters are used at both ends and at intermediate switching stations on practically all lines considered, and the disturbance reports indicate that they have aided materially in cutting down the violence of line surges.

Sleet caused longer outages than any other trouble, due, in part, to the actual damage done to the conductors and carrying structures and in part to the difficulty

Table I—Physical Data on Twenty Transmission Lines

Line No.	Location	Total Length, Miles	No. of Taps	No. of Circuits	Approximate Voltage	Capacity per Circuit	Span, Ft.	Insulation Normal Rating	Ground Wire	Lightning Arresters	Type of Construction	Conductor Spacing Ft.	Conductors
1	West	240.6	At 4 and 238 miles	1	Over 200,000	125,000 kw.	660	.....	⅜ in. galv. steel	None	Flat	17.25	Aluminum steel cable, 605,000 cire.mil.
2	West	240.6	At 4 and 240 miles	1	Over 200,000	125,000 kw.	660	.....	⅜ in. galv. steel	None	Flat	17.25	Aluminum steel cable, 605,000 cire.mil.
3	Middle West	147.8	At 101 and 131 miles	1	Over 120,000	75,000 kw.	528	370,000	No	Yes	Steel tower, vertical	12 ft. vert.	Seven strand copper, 110,000 cire.mil.
4	Middle West	40	None	2	Over 120,000	Max, 125,000	1,200	.....	One added 1926	Yes	Steel tower, vertical	14 ft. vert. middle cond. Offset 3.5 ft.	Copper, 300,000 cire.mil.
5	Middle West	51	None	1	Over 120,000	10,000 kva. Limited by trans. capacity	600	400,000	⅜ in. copperweld	Yes	Steel tower, vertical	12 ft. vert. middle cond. Offset 2.0 ft.	No 3/0 A.C.S.R.
6	South	89	None	1	Over 85,000	35,000 kva.	.....	132,000	2	Yes	Wood pole H-frame	.....	Copper, 250,000 cire.mil.
7	South	87.5	None	2	Over 85,000	20,000 kva.	.....	200,000	1	Yes	Steel tower	.....	No. 4/0 copper
8	West	153	At 34.6 and 58.4 miles	1	Over 85,000	10,000 kva.	720	.....	None	Yes	Steel pole, flat	11 ft. horizontal	No. 0 hemp-core copper
9	West	28	None	1	Over 85,000	14,000 kva. max.	.....	.....	.....	.....	.....	.....	.....
10	West	27	None	1	Over 85,000	22,500 kva.	800	.....	None	Yes	Steel tower vertical	12 ft. vertical	A.C.S.R. 336,000 cire.mil.
11	West	8	None	1	Over 85,000	.....	720	.....	None	Yes	Steel tower, flat	11 ft. flat	No. 1 copper-hemp core
12	South	75	1 at 37.5 miles	1	Over 60,000	22,500 kva.	800	.....	None	Yes	Steel tower, flat	14 ft. 6 in. flat	A.C.S.R. 336,000 cire.mil.
13	East	63.1	at 4 points	2	Over 60,000	10,000 kva.	.....	125,000	None	Yes	Wood pole wishbone	11 ft.	No. 2/0 copper
14	Middle West	7.1	1-each circuit at center	2	Over 60,000	10,000 kva.	550	70,000	Yes	Yes	Steel tower	.....	No. 2 copper, No 1/0 copper, No. 4/0 aluminum, No. 2/0 aluminum
15	Middle West	10.2	1-each circuit at center	2	Over 60,000	18,000 kva.	472	.....	2-yes	Yes	Steel tower	7 ft. 8 in.	No. 1/0 copper
16	Middle West	35	1 point	2	Over 60,000	18,000 kva.	472	.....	2-yes	Yes	Steel tower	7 ft. 8 in.	No. 1/0 copper
17	Middle West	25	None	1	Over 60,000	10,000 kva.	.....	.....	None	Yes	Wood pole, flat	.....	.....
18	West	117	.....	1	Over 60,000	10,000 kva.	.....	.....	None	Yes	Wood pole, flat	.....	.....
19	West	55	.....	2	Over 60,000	.....	700	.....	None	None	Steel tower inverted triangle	.....	No. 4/0 copper
20	West	102.2	.....	1	Over 60,000	14,500 kva. max.	660 towers 180 poles	.....	None	None	Steel tower, vertical Steel pole, vertical	12 ft. 7 ft.	No. 4/0 copper No. 4/0 and No. 3/0 copper
									None	.....	Wood-pole triangular-pin insulators	.....	.....

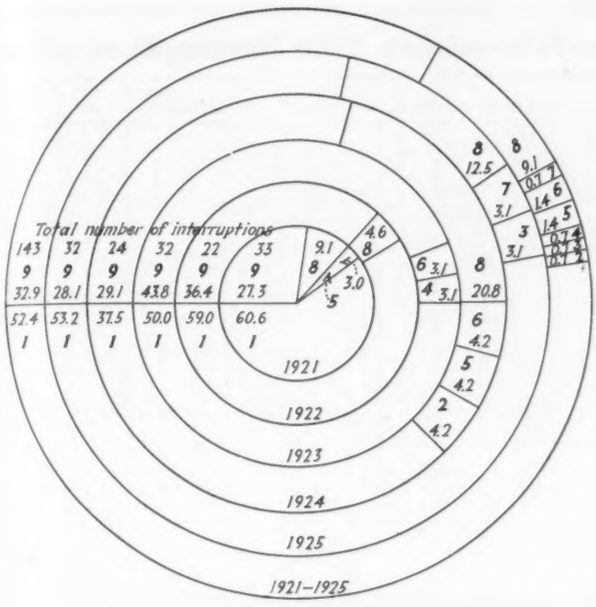


FIG. 1—CAUSES OF INTERRUPTIONS IN PER CENT ON 89-MILE 110-KV. LINE

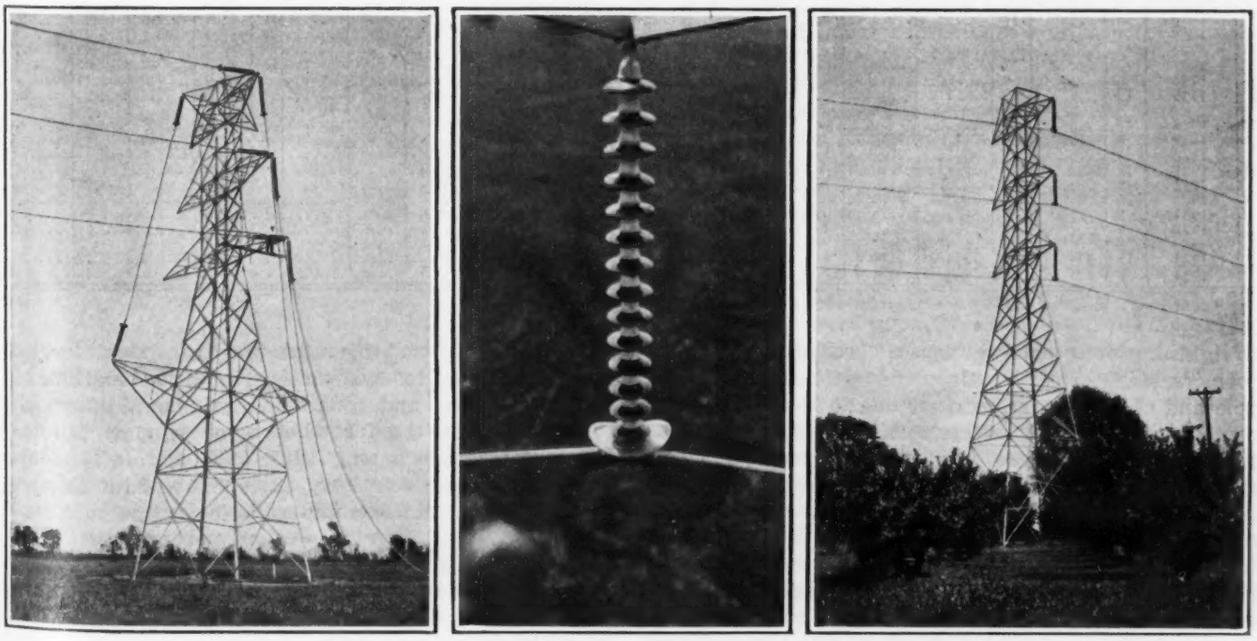
Key: 1. Lightning
2. Insulator failure
3. Insulator flashover
4. Line wire failure
5. Line structure failure
6. Wind storm
7. Telephone line in transmission line
8. Unknown
9. System trouble not due to failure or trouble on line considered.

FIG. 2—DURATION OF INTERRUPTIONS IN PER CENT ON AN 89-MILE 110-KV. LINE

Key: 1. Lightning
2. Insulator failure
3. Insulator flashover
4. Line wire failure
5. Line structure failure
6. Wind storm
7. Telephone line in transmission line.
8. Unknown
9. System trouble not due to failure or trouble on line considered.

of getting men and material over roads made impassable by the storm. Some companies operating in sleet districts have operating plans for warming conductors to keep sleet from forming on the conductors on stretches of trunk line, but in many cases the nature of the line makes this impossible and reliance must be placed on the mechanical strength of the conductors and towers. Wind, ice, rain and snow accounted for a comparatively small percentage of interruptions, and in most lines there were no outages chargeable to these causes in 1924 or 1925. Line No. 8 is built through mountainous country at a high altitude, where strong winds and snowslides are prevalent during a major part of the year. The fact that the line has been in operation since 1907 shows that lines can be built strong enough to meet such conditions.

Equipment and mechanical failures as listed in the table include insulator breakage not directly chargeable



CONSTRUCTION DETAILS OF THE THIRD 220-KV. LINE TO BE BUILT IN CALIFORNIA

The Great Western Power Company will complete in June a 102-mile, 100,000-kw., single circuit line (later double circuit) between the Brighton substation near Sacramento and the Wilson substation of the San Joaquin Light & Power Corporation, near Merced. The view on the left shows a combination transposition and dead-end tower, the right view is one of the standard towers and the one in the center is a close-up of one of the thirteen-unit insulator strings with a corona shield.

Table II—Transmission Line Interruptions—Number

Line No.	Year	No. of Int.	Duration	Service Interruptions: No.	Service Interruptions: Duration	Service Interruptions: Max. Duration	Lightning: No.	Lightning: Per Cent of S. I. (x)	Lightning: Duration	Lightning: Per Cent of S. I. (x)	Lightning: Max. Duration	Sleet, Snow, Wind, Rain, Ice: No.	Sleet, Snow, Wind, Rain, Ice: Per Cent of S. I. (x)	Sleet, Snow, Wind, Rain, Ice: Duration	Sleet, Snow, Wind, Rain, Ice: Per Cent of S. I. (x)	Sleet, Snow, Wind, Rain, Ice: Max. Duration	Equipment and Mechanical Failure: No.	Equipment and Mechanical Failure: Per Cent of S. I. (x)	Equipment and Mechanical Failure: Duration	Equipment and Mechanical Failure: Per Cent of S. I. (x)	Equipment and Mechanical Failure: Max. Duration	Oper- : No.	Oper- : Per Cent of S. I. (x)
1	1920	12	37.75	12	37.75	24.0	1	8.3	1.0	2.6	1												
	1921	19	57.2	19	57.2	13.5						2	10.5	3.5	6.1	3.5							
	1922	16	19.8	16	19.8	3.0	1	6.3	1.5	7.6	1.6						1	6.3	1.0	5.1	1.0	1	6.2
	4 mos. 1923	5	12.0	5	12.0	9.0	1	20.0	9.0	75.0	9.0												
	8 mos. 1923	68	125.5	68	125.5	60.8						17	21.1	8.6	6.8	.7	1	4.7	60.0	47.8	60.0	1	4.7
	1924	11	47.4	11	47.4	27.0											2	18.2	4.0	8.4	2.0	1	9.1
	1925	16	12.5	16	12.5	8.5						1	6.3	0.5	4.0	.5							
2	1920	10	718.0	10	718.0	708.0						1	10.0	2.0	.3	2.0	1	10.0	708.0	98.7	708.0		
	1921	7	9.3	7	9.3	2.8						1	14.3	Inst.									
	1922	12	36.7	12	36.7	9.0																1	8.3
	4 mos. 1923	4	3.3	4	3.3	1.5																1	25.0
	8 mos. 1923	62	103.3	62	103.3	60.0						16	25.8	6.3	6.1	.5	2	3.3	60.3	58.3	60.0	1	1.6
	1924	13	16.5	13	16.5	3.5																	
	1925	24	12.3	24	12.3	4.5						1	4.2	0.3	2.5	.3							
3	1921	6	2290.0	6	2290.0	840.0	4	66.6	1440.0	63.0	480.0	1	16.3	840.0	36.6	840.0	1	16.3	10.0	.4	10.0		
	1922	9	18120.0	9	18120.0	15840.0	4	44.5	1080.0	5.9	720.0	3	33.3	16440.0	90.7	1584.0	2	22.2	600.0	3.3	600.0		
	1923	9	5320.0	9	5320.0	2160.0	6	66.7	1810.0	34.0	1140.0	1	11.1	2160.0	40.6	216.0							
	1924	3	2295.0	3	2295.0	930.0	3	100.0	2295.0	100.0	930.0												
	1925	30	8216.0	2	34.0	29.0	1	50.0	5.0	14.7	5.0												
4	1925	15	*4486.0	14	4486.0	1427.0	14	100.0	4486.0	100.0	1427.0												
5	1925	19	84.5	18	16.5	9.0	16	89.0	14.5	88.0	9.0												
6	1921	33	3119.0	33	3119.0	2926.0	20	60.7	53.0	1.6	14.0						1	3.0	2926.0	93.8	2926.0		
	1922	22	111.0	22	111.0	25.0	13	59.0	58.0	52.3	25.0												
	1923	32	646.0	32	646.0	514.0	16	50.0	43.0	6.6	7.0	1	3.1	2.0	.3	2.0	1	3.1	514.0	79.5	514.0		
	1924	24	2302.0	24	2302.0	976.0	9	37.5	37.5	1.6	6.0	1	4.2	2.0	.09	2.0	2	8.4	1517.0	66.0	976.0	1	4.2
	1925	32	141.0	32	141.0	23.0	17	53.0	71.0	50.0	16.0											1	3.1
7	1922	27	58.5	27	58.5	6.0	8	29.6	13.5	23.0	6.0						7	26.0	19.0	32.5	5.5	3	11.1
	1923	37	57.3	34	54.3	9.0	7	20.6	8.8	16.2	5.0	1	2.9	0.5	.9	.5	9	26.5	17.5	32.1	7.0	3	8.8
	1924	55	181.0	55	181.0	55.0	1	1.8	1.0	.5	1.0						4	7.2	64.5	35.6	55.0		
	1925	15	55.5	15	55.5	13.0	6	40.0	11.0	20.0	4.0						4	26.7	24.0	43.4	13.0	1	6.7
8	1925	78	6383.0	78	6383.0	2861.0	55	70.5	1673.0	26.1	541.0	8	10.2	22.0	.3	6.0	6	7.7	3648.0	57.2	2861.0	2	2.6
9	1925	7	35.0	7	35.0	19.0	4	57.0	10.0	28.3	6.0						1	14.3	19.0	54.5	19.0	1	14.3
10	1925	6	66.5	6	66.5	34.0	5	83.3	32.5	49.0	21.0											1	16.7
11	1925	1	21.0	1	21.0	21.0	1	100.0	21.0	100.0	21.0												
12	1922	171	691.8	171	691.8	133.0	25	14.6	22.0	3.2	2.0						24	14.0	172.0	24.9	59.0	49	28.6
	1923	179	5105.5	179	5105.5	929.0	18	10.0	43.0	.8	8.0						21	11.7	4383.5	86.0	929.0	51	28.5
	1924	90	1326.0	90	1326.0	703.0	6	6.7	17.5	1.3	10.0						13	14.5	984.0	74.0	703.0	20	22.2
	1925	24	295.0	24	295.0	89.0	11	46.0	52.0	17.6	12.0	1	4.1	1.0	.3	1.0	9	37.6	199.0	67.5	89.0	1	4.1
13	1922	17	807.5	17	807.5	258.0	7	41.0	113.5	14.0	45.0	3	18.0	290.0	36.0	170.0	7	41.0	404.0	50.0	258.0		
	1923	19	186.0	19	186.0	40.0	3	15.8	23.0	12.4	15.0	3	15.8	32.0	17.2	23.0	5	26.3	51.0	27.4	16.0	3	15.8
	1924	27	447.0	27	447.0	105.0	4	14.8	42.0	9.4	18.0	9	33.0	212.0	47.4	105.0	8	29.6	122.0	27.3	26.0	2	7.4
	1925	7	218.5	7	218.5	105.0	5	71.4	53.5	24.2	25.0	1	14.3	60.0	26.8	60.0							
14	9 mos. 1925	12	69.0	12	69.0	17.0	6	50.0	21.0	30.5	15.0												
15	9 mos. 1925	9	47.0	9	47.0	17.0	4	44.5	4.0	8.5	4.0												
16	1925	9	847.0	2	35.0	34.0	2	100.0	35.0	100.0	34.0												
17	1925	43	10926.0	3	239.0	119.0	1	33.3	24.0	10.0	24.0						1	33.3	119.0	49.7	119.0		
18	1918	68	.....	68	.....	.....	6	8.8	.....	.....	.....	5	7.4	.....	.....	.....	32	47.0	.....	.....	.....	1	1.5
	1919	34	.....	34	.....	.....						1	2.9				10	29.0					
	1920	39	.....	39	.....	.....	6	15.8				1	2.6				17	43.5				1	2.6
	1921	51	.....	51	.....	.....						1	1.9				20	39.2					
	1922	66	.....	66	.....	.....						2	3.0				39	59.0				3	4.5
	1923	42	.....	42	.....	.....											17	40.5				1	2.2
	1924	50	.....	50	.....	.....	2	4.0				2	4.0				4	8.0				1	2.0
	1925	15	.....	15	.....	.....	6	40.0									1	6.6					
19	1918	17	.....	17	.....	.....	6	35.3	.....	.....	.....	3	17.6	.....	.....	.....	5	29.4	.....	.....	.....		
	1919	6	.....	6	.....	.....											3	50.0					
	1920	11	.....	11	.....	.....	1	9.1				1	9.1				4	36.3					
	1921	15	.....	15	.....	.....						5	33.3				6	40.0					
	1922	10	.....	10	.....	.....						3	30.0				4	40.0					
	1923	20	.....	20	.....	.....						1	5.0				5	25.0				1	5.0
	1924	9	.....	9	.....	.....											1	11.0					
	1925	9	.....	9	.....	.....	2	22.3				2	22.3										
20	1923	13	2343.0	13	2343.0	1112.0	1	7.7	399.0	18.7	399.0												
	1924	6	2034.5	6	2034.5	678.0																	

* No record of one. (x) S. I.—Service interruptions.

to lightning or to external causes; breakdown of transformers, transformer bushings and switches; and tower, pole and conductor failures not due to sleet. The percentage of the total interruptions for this class was not large, but the time duration per interruption was longer than for any other cause than sleet and it is to be expected that the actual cost for necessary repairs alone was in the same proportion. On the first seventeen lines listed in the table there were twenty-one failures of more than one hour due to equipment failure, with a total time duration of 14,356 minutes. This represents 1.6 per cent of the total number of interruptions on the seventeen lines and 25.7 per cent of the total time duration of 55,767.95 minutes.

The company that operates line No. 3 has devoted much attention to systematic inspection and maintenance of lines and connected equipment, the result being shown by the fact that there were no failures due to this cause during 1923, 1924 and 1925. This does not tell the whole story, since many of the failures chargeable to lightning had caused damage to equipment, but with closer inspection and replacement of weak parts the lightning outages decreased in both number and duration. The same results are apparent on lines Nos. 12, 18 and 19, though no duration of interruptions was reported on the last two. With the experience of companies showing a positive preventive remedy for this type of failure, which has caused a

nd Duration in Minutes

ng Errors			External Causes					Flashovers and Unknown				
Duration	Per Cent of S. I. (x)	Max. Duration	No.	Per Cent of S. I. (x)	Duration	Per Cent of S. I. (x)	Max. Duration	No.	Per Cent of S. I. (x)	Duration	Per Cent of S. I. (x)	Max. Duration
			1	5.3	0.2	0.3	0.2	11	91.7	36.75	97.4	24.0
			1	6.2	No report			16	84.2	53.5	93.6	13.5
3.0	15.3	3.0	1	20.0	1.5	12.5	1.5	12	75.0	14.3	72.0	12.0
6.0	4.8	6.0	14	23.0	9.8	7.8	1.5	3	60.0	1.5	12.5	1.0
27.0	57.0	27.0						35	46.5	41.1	32.8	7.0
								8	72.7	16.4	34.6	7.0
								15	93.7	12.0	96.0	8.5
								8	80.0	8.0	1.0	1.5
			2	28.6	2.0	21.2	1.5	4	57.1	7.3	78.8	2.8
1.0	2.7	1.0	4	33.2	17.2	46.9	9.0	7	58.5	18.5	50.4	8.0
1.0	30.0	1.0	1	25.0	None reported			2	50.0	2.3	70.0	1.5
1.0	0.9	1.0	14	22.3	9.8	9.5	1.0	34	47.0	25.9	25.2	3.0
								13	100.0	16.5	100.0	3.5
			3	12.5	3†	25.0	2.0	20	83.3	9.0	72.5	4.5
			2	22.2	1350.0	40.6	750.0					
								1	50.0	29.0	85.3	29.0
			2	11.0	2.0	12.0	1.0					
			9	27.1	134.0	4.2	82.0	3	9.2	6.0	.4	2.0
			8	36.2	48.0	43.3	7.0	1	4.8	5.0	4.4	5.0
			14	43.8	87.0	13.6	22.0					
4.0	0.2	4.0	6	25.0	28.0	1.3	10.0	5	20.7	726.0	30.9	715.0
3.0	2.1	3.0	9	28.0	51.0	36.2	23.0	5	15.9	16.0	11.7	4.0
10.5	18.0	5.0	7	26.0	13.5	23.0	5.5	2	7.3	2.0	4.0	1.5
10.5	19.4	9.0	14	41.2	17.0	31.4	6.0					
			48	87.4	109.0	60.5	12.0	2	3.6	6.5	3.4	6.0
.5	.09	.5	3	19.9	17.0	30.6	10.0	1	6.7	3.0	5.1	3.0
6.0	.1	5.0	2	2.6	1021.0	16.0	511.0	5	6.4	13.0	.3	4.0
3.0	8.6	3.0						1	14.4	3.0	8.6	3.0
34.0	51.0	34.0										
93.3	12.3	15.0	71	41.5	279.0	40.3	70.0	2	1.3	133.5	19.3	133.0
80.0	1.6	5.0	55	30.7	475.5	10.3	68.0	34	19.1	123.5	2.3	13.0
10.5	7.7	44.0	46	51.0	200.5	15.1	70.0	5	5.6	13.5	1.9	6.0
41.0	13.9	41.0	2	8.2	2.0	.7	1.0					
51.0	27.4	40.0						5	26.3	29.0	15.6	15.0
43.0	9.3	38.0	1	3.7	3.0	1.6	3.0	2	7.4	20.0	5.0	11.0
								1	14.3	105.0	49.0	105.0
			5	41.7	48.0	69.5	17.0	1	8.3	Inst.		
			2	22.2	33.0	70.2	17.0	3	33.3	10.0	21.3	10.0
			1	33.4	96.0	40.3	96.0					
								8	11.7			
			16	23.6				15	44.0			
			8	24.1				7	19.0			
			7	19.1				9	17.8			
			21	41.1				8	12.4			
			14	21.1				8	19.1			
			16	38.2				10	20.0			
			31	62.0				1	6.7			
			7	46.7								
			2	11.8				1	5.7			
			3	50.0								
			1	9.1				4	36.4			
								4	26.7			
			1	10.0				2	20.0			
			9	45.0				4	20.0			
			4	44.5				4	44.5			
			4	44.5				2	22.2			
			12	92.3	194.4	81.3	1112.0					
			3	50.0	615.5	29.8	336.0	3	50.0	141.9	70.2	678

†No time on one.

comparatively large portion of the total time interruption, it seems to offer one of the surest ways to approach 100 per cent service.

Operating errors are the least weighty cause of failure and due to safety methods now being enforced and standardized operating practice should become even less. The operating errors for line No. 12 were due to switching arrangements existing at the time and could not be avoided.

External causes include outages due to trouble on other lines of the system, generating plant failures and foreign objects in the line. The reports of some companies did not show interruptions chargeable to the remainder of the system, but the report for lines Nos. 7 and 12 is complete in this respect and shows the interdependence of a transmission system and the necessity of a protective relay system that will localize trouble. Seventy-two interruptions were charged to external causes on line No. 7 between 1922 and 1925, of which 50 were due to other lines of the company and twenty were due to trouble on interconnecting companies. Line No. 12 had 174 failures due to external causes during the same period, of which 56 were due to system trouble and 108 to trouble on other companies' lines. The generally improved condition of operation is shown, however, by the fact that in 1925 line No. 12 had only one failure due to system trouble and line No. 7 one, and that line No. 7 had two failures and line No. 12 one chargeable to trouble on interconnected companies.

Interruptions due to flashovers (including overload) and unknown causes are being reduced on all lines on which a record over several years is available. Examination of the record of this class of failure on lines Nos. 1 and 2 shows that operating difficulties on high-voltage lines are being steadily overcome. Both of

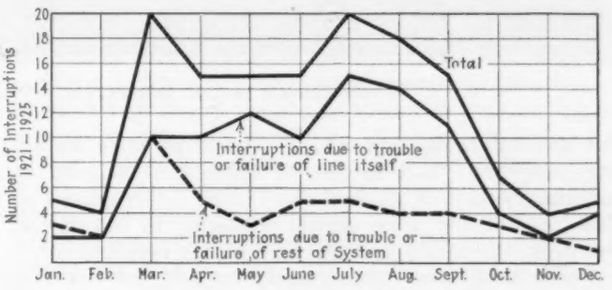
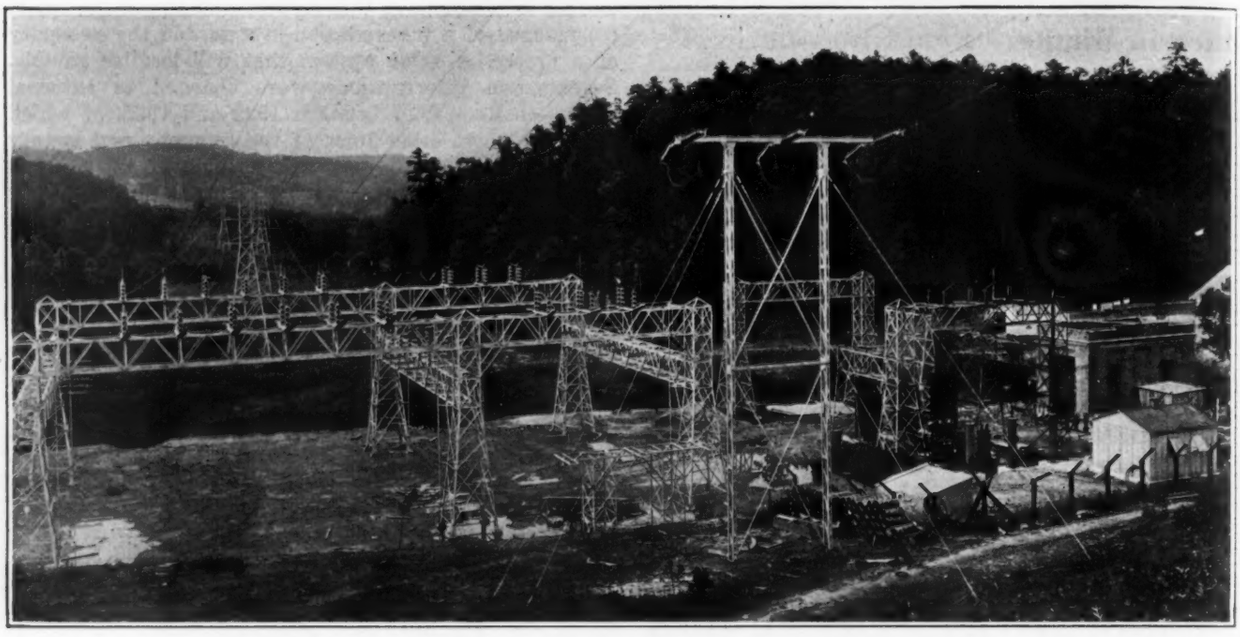


FIG. 3—INTERRUPTIONS ACCORDING TO THE MONTH OF THE YEAR

these lines were operating at 150,000 volts on Jan. 1, 1920, and continued at that voltage until about May 1, 1923, when they were raised to 220,000 volts. A steady drop in the number and duration of interruptions took place until the raise in voltage, when there was a great increase in each case. During 1924 and 1925, however, the duration of interruptions decreased once more. It is particularly noticeable that although the number of flashovers and unknown interruptions in 1925 was greater than in 1924, the average of each interruption was reduced from 1 minute (1924) to 0.8 minute (1925) on line No. 1; from 1.3 minute (1924) to 0.45 minute (1925) on line No. 2, and that both lines were clearing themselves of trouble in most cases with no interruption to service. During 1925 there were six cases on line No. 1 and six on No. 2 in which the time to restore line voltage to normal was between one second and 30 seconds; there were seven occasions on No. 1 and nine on No. 2 in which this time was one second or less.

Periodic testing and cleaning of dirty insulators play an important part in the general reduction of flashovers on many of the lines that were troubled with dirty insulators due to bird-dirt, heavy dust or similar reasons. Bird-guards are also being widely used on lines where birds have caused trouble by lighting on the towers and conductors.

In order to show in more detail the outage record for an individual line, the accompanying charts based on the record of line No. 6 for the period 1921 to 1925 are included. Interruptions due to insulator failure, line wire failure and line structure failure were included under equipment and mechanical failures in



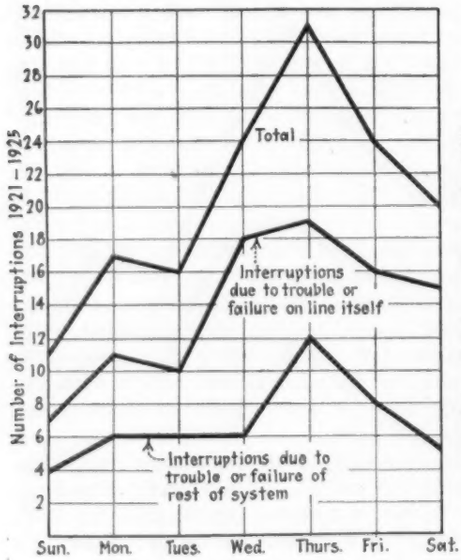
THE 110-KV. TOCCOA SUBSTATION OF THE GEORGIA RAILWAY & POWER COMPANY

the general table, and No. 7 (telephone wire swinging into line) and system troubles are included in external causes. Figs. 3, 4 and 5 show interruptions on this line for the same period according to the day of the week, the month and the time of day respectively.

These charts, of course, apply to only the one line under its own operating conditions, but they suggest the way in which a study may be made graphically of any line during an analysis of its interruption troubles. For example, the interruption peak comes at 5 p.m., but the peak of interruptions due to the line itself is at 3 p.m. This might mean that most of the system trouble occurred while dropping load in the afternoon, particularly since there is another smaller peak at 7 a.m., when load is being picked up, and a third at 10 p.m., when the lighting load is going off.

An attempt was made to determine the influence of higher voltages on the frequency of interruptions in general and lightning interruptions in particular, but none could be found, and the influencing conditions seem to be more the nature of the country through which the line passes, the frequency and intensity of storms, the safety factor in insulation and other protective equipment and the thoroughness with which insulators, the lines and connected equipment had been inspected and maintained.

The increasing success attained by some companies whose lines are operated through unfavorable country shows that difficulties are being overcome and an examination of the time lost due to line failures shows the dollars and cents return possible on additional investment to insure transmission line reliability. Engineering problems are now well understood and offer no difficulties in line design.


Number of Interruptions 1921-1925
Total
Interruptions due to trouble or failure on line itself
Interruptions due to trouble or failure of rest of system
Sun. Mon. Tues. Wed. Thurs. Fri. Sat.

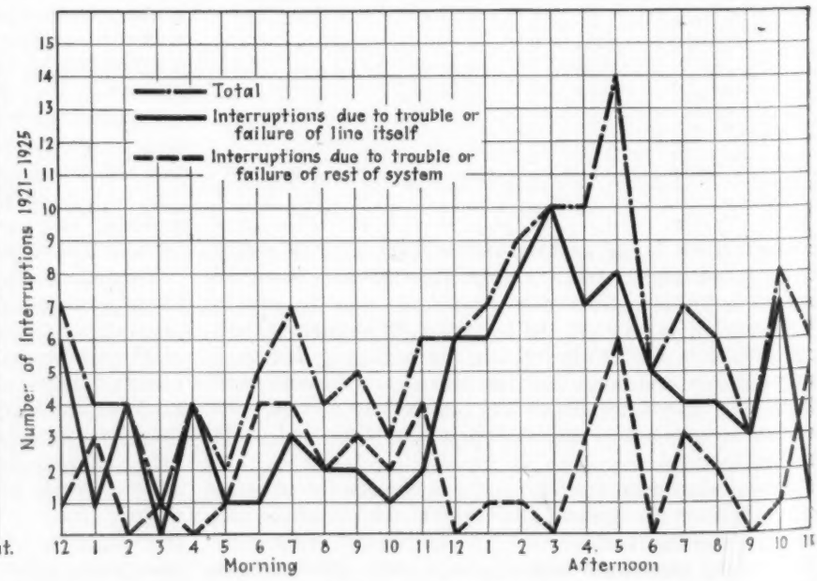

Number of Interruptions 1921-1925
Total
Interruptions due to trouble or failure of line itself
Interruptions due to trouble or failure of rest of system
Morning
Afternoon

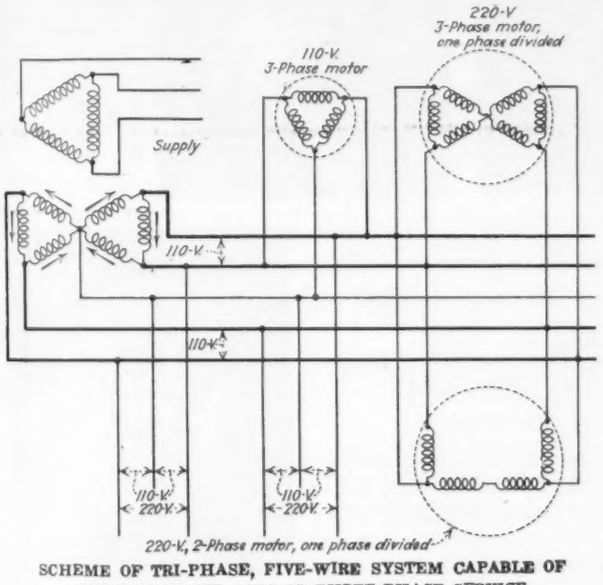
FIG. 4 (AT LEFT)—INTERRUPTIONS ACCORDING TO THE DAY OF THE WEEK. FIG. 5 (AT RIGHT)—INTERRUPTIONS ACCORDING TO THE HOUR OF THE DAY

A Triple-Phase, Five-Wire Distribution System

Suggested Scheme for Supplying One, Two, or Three-Phase Services from Same Distribution System—Possible Adaptation to Existing Two-Phase Systems to Secure Three-Phase Advantages

By A. A. Nims
Associate Professor of Electrical Engineering, College of Engineering, Newark, N. J.

IN VIEW of the present engineering interest in distribution systems and the economic importance of extended application or increased flexibility of such systems, one proposed some years ago has possibilities worthy of serious consideration. Although the layout was suggested originally for high-voltage transmission purposes, it has many advantages of both three-phase, four-wire and two-phase, five-wire systems when applied to distribution circuits. Its distinctive characteristics are the facility with which growth of load may be taken care of and the possibility of supplying both two-phase and three-phase motors from the same lines.



SCHEME OF TRI-PHASE, FIVE-WIRE SYSTEM CAPABLE OF SUPPLYING ONE, TWO OR THREE-PHASE SERVICE

The simplest element of the system, used for circuits supplying at first only single-phase loads, is the ordinary 220/110-volt, three-wire circuit. As the load approaches the capacity of this circuit, its capacity is doubled with the addition of two more wires at 220 volts, using the middle wire of the first circuit as a common neutral. In the two-phase, five-wire system the voltage of the second circuit would be 90 deg. from that of the first circuit. If this phase difference is made 120 deg. instead of 90 deg., the proposed system is obtained, as shown in the diagram.

The 220/110-volt, single-phase circuits are unchanged, except that there are now possible two additional 110-volt circuits, neither side of either of which is at ground potential. Furthermore, two 110-volt, three-phase circuits are now available.

The two voltages to supply this system may be secured from any three-phase line, through two transformers with V-connected primaries and secondaries joined at their middle points. If full advantage is to be taken of three-phase transformation, this may be done by splitting the secondary of the third transformer and connecting the parts to the two pairs of outside wires.

Furthermore, polyphase motors, arranged so that one phase can be cut into two equal parts, may be connected to the four outside wires. By means of this special connection 220-volt motors may be operated from this system, as shown at the right of the diagram. Both voltage and phase relations are correct for three-phase motors. For a two-phase motor there is a 13 per cent unbalance in voltage, which will cause the rotating field to be slightly elliptical but will have little effect on the practical operation of the motor.

When the load outgrows the five wires at this voltage, the voltage may be doubled, using balance coils to supply the 110-volt, single-phase load. With the special connections, 440-volt, two-phase and three-phase motors may be operated from the four outside wires, and standard 220-volt, three-phase motors may be connected between the neutral and each of the two pairs of outside wires.

In case the initial installation has to supply a power load as well as lighting, it would naturally be made as a standard 220-volt, three-phase circuit, with a balance coil across one of the phases to supply the lighting. The two other wires will then be added as the demand increases. Thus the addition of two wires doubles the capacity of the initial three-wire circuit, whether it be single phase or three phase.

The enlargement may also be made with one wire, by omitting the neutral wire and operating as a four-wire system. This necessitates a divided phase on all polyphase motors and the connection of all lighting circuits to the low-voltage wires, unless balance coils are used. If the maximum voltage of the system is 440, balance coils would be necessary for the lighting.

The load capacity of this three-phase, four-wire or five-wire system depends upon the manner in which its load is connected. It is maxumum when the load is equally divided between the two circuits of maximum voltage, E, and is equal to $2EI$ where I is the current capacity of each main. If a balanced three-phase load is connected, the capacity is $2(\sqrt{3}EI) \div 2 = \sqrt{3}EI$.

A tabulated comparison of the proposed system, which is designated by the term tri-phase, with the usual three-phase, four-wire, and two-phase, five-wire systems, both with neutral, shows relative volt-ampere capacities as follows, based on maximum voltage between wires E and a current per main wire I:

System	Four-Wire	Five-Wire
Tri-phase, maximum load....	$2EI$	$2EI$
Tri-phase, three-phase load...	$\sqrt{3}EI$	$\sqrt{3}EI$
Three-phase, with neutral...	$\sqrt{3}EI$	.....
Two-phase, with neutral.....	.....	$2EI$

It appears then that the proposed system has the same capacity as the three-phase, four-wire system, with the further advantages of better voltages for motors and lights and ability to supply either two-phase or three-phase power.

It is also possible to derive this four-wire distribution system from a two-phase, high-voltage line by the use of special transformers, similar to those for Scott transformation to three phase. A more symmetrical arrangement may be obtained by using two equal teaser windings and completing the mesh.

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EACH CITY HAS A RESIDENTIAL SECTION WAITING FOR INTENSIFIED ELECTRIC SERVICE

Philadelphia Residence Studies

Effect of Rate Structure, Merchandising, Dilution and Saturation Measured—Consumption Increased 120 per Cent Since 1915 —Load Factors and Demands of Appliances Determined

By CHARLES J. RUSSELL
Vice-President Philadelphia Electric Company

SIX YEARS of systematic study of the residence business in Philadelphia has resulted in the accumulation of data that indicate the importance of such continuous study by any public utility.

During the period covered by these data the number of residence customers has increased by 218,703, or from 100,358 to 319,061. As may be expected from these figures, a very large dilution in the average use of energy per customer resulted. Unwired properties to the number of 176,503 were equipped and connected up, and a very large percentage of these called for the financing of the wiring and fixtures upon a deferred payment plan. It is a fact that taking advantage of an easy plan of payment does not necessarily prove the financial status of a residential customer, but it is also a fact that during the year or eighteen months covered by such payments economy is practiced in the use of electric service and the purchase of current-consuming devices is postponed for some time after the service is put in. It is also a fact that it takes some time to educate the customer as to the advantages of electrical service, which is another cause for a material delay in the electrical equipment of the home outside of such minor devices as the electric iron, toaster, etc. The dilution resulting from the addition of a large number of customers of this class has, in consequence of these facts, a marked effect upon average results.

These statements simply define the breadth of the experience upon which progressive data have been based.

The importance of the residence business from the standpoint of public relations, the duty of the utility in market development, the stabilizing influence upon revenue, etc., were fully appreciated from the first. In the face of the fact that the existing residential business did not carry its own burdens of customer and investment expense, a strong faith in the future of the business led to the adoption of a definite policy of increasing the saturation of this class of business through intensive sales efforts where distribution facilities existed. Aggressive merchandising methods, accompanied by educational work along general advertising, lecture and demonstration lines aimed at increasing kilowatt-hour sales of energy in existing installations, were carried on. Four rate reductions in the residence class were made and their effects carefully studied. The first of these affected the base rate, the second and fourth shortened the hours of use in the second block, whereas the third reduction lowered the follow-on rate from five to three cents per kilowatt-hour.

SATURATION DECREASES UNIT INVESTMENT

Stated briefly, the results of increased saturation decreased the distribution investment per customer to a marked extent. The customer expense was reduced somewhat, but it seems to be an established fact that increased numbers of customers do not bring about a material reduction per customer in those items of cost covering billing, collecting and the other customer expenses.

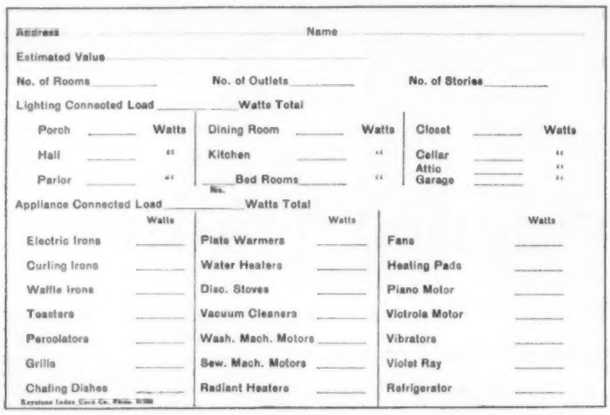
The kilowatt-hours sold per customer have, notwithstanding the dilution, kept up and even increased slightly. Upon analysis it is found that this is due

to a marked increase in consumption by the older customers (on the order of 50 per cent in six years), which has sustained the average.

PRESENT STATUS OF THE BUSINESS

From the standpoint of return, the business, with the last rate reduction effective, is practically on the same basis, except as to volume, as it was six years ago. The present condition has, however, been brought about as the result of the definite policy of increasing saturation, intensifying energy sales and reducing rates with the object of building a rate structure capable of progressively taking care of the residence business from the customers' and company's viewpoint.

It is believed in Philadelphia that the residence field


Address Name
Estimated Value
No. of Rooms No. of Outlets No. of Stories
Lighting Connected Load Watts Total

Porch	Watts	Dining Room	Watts	Closet	Watts
Hall	"	Kitchen	"	Cellar	"
Parlor	"	No. Bed Rooms	"	Attic	"
				Garage	"

Appliance Connected Load Watts Total

	Watts		Watts		Watts
Electric Irons		Plate Warmers		Fans	
Curling Irons		Water Heaters		Heating Pads	
Waffle Irons		Disc. Stoves		Piano Motor	
Toasters		Vacuum Cleaners		Victrola Motor	
Percolators		Wash. Mach. Motors		Vibrators	
Grills		Sew. Mach. Motors		Violet Ray	
Chafing Dishes		Radiant Heaters		Refrigerator	

Keystone Index Card Co. Phila. 9/25

FIG. 1—SAMPLE OF RESIDENCE SURVEY CARD

offers the greatest opportunity for development presented by any existing class of business. It seems certain that since no form of service is more popular than electric service in the home, the development of the business to the maximum extent should be of great benefit in cementing public relations in the community. Analyses of many cases indicate that although residences of a given class do not make a return of out-of-pocket expenses and a pro rata return upon investment, the intensification of sales by a few kilowatt-hours per month may change an apparent loss to at least an even break.

It is possible that certain observations made during the accumulation of these data may be of interest.

The first of these is what may be called the budget character of expenditures for electric service in the home. This influence prevails to a marked degree in the case of mechanics or others with a fixed but moderate income, and these constitute a very large percentage of the residence customers. The apparent effect is that a relatively fixed annual amount will be expended for lighting and minor appliance service in the home with an increase in use under decreased rates up

Table I—Growth in Consumption, 1915 to 1925, for Typical Residence Customers in Philadelphia

6 Rooms	Number of Houses	Monthly Consumption Kw.-Hr. 1915	Monthly Consumption Kw.-Hr. 1925	Per Cent Increase
South 23d Street	59	14.2	32.9	132
South 24th Street	28	15.9	32.3	103
North Franklin Street	26	12.7	30.0	136
North Franklin Street	58	10.9	27.5	152
North 8th Street	13	10.9	43.2	296
Jasper Street	11	20.5	33.0	61
Bailey Street	66	10.5	24.4	132
Judson Street	61	13.5	25.0	85.2
7 Rooms				
Alter Street	40	12.3	27.0	119.5
East Atlantic Street	8	11.4	27.6	142
Cedarhurst Street	53	17.0	37.5	117.6
Ellsworth Street	44	13.7	28.6	108.7
North 21st Street	24	11.3	27.3	142
8 Rooms				
West Durham Street	26	13.2	28.9	119
9 Rooms				
West Louden Street	3	17.1	28.9	69
12 Rooms				
North Park Avenue	23	26.7	66.3	148
14 Rooms				
North Park Avenue	29	34.2	70.8	107
West Lehigh Avenue	12	40.4	75.8	87.8
Grand average	584	15.5	34.1	120

to practically the original annual expenditure. It would appear that considerable resistance exists to an increase in the annual expenditure even in the face of continual educational effort as to the advantages and economic benefits of a more liberal use of electric service. The substitution of a new form of electric service in the household for an existing form provided for under a different budget item seems the only method of rapidly breaking down the resistance to an increase of the annual budget for electric service. Electric cooking, refrigeration and electric methods of using cheap fuel are instances of electric service that combine expenditures under separate budgets.

Social surveys of household conditions, including incomes and expenditures, are of material value in defining the limitations of electric sales and in indicating the trend of expenditures for other purposes than the relief of household drudgery and the complete electrification of the home. The present cost of residential buildings has a marked effect upon the amount of money available from ordinary incomes for electrical equip-

Table II—Results of Survey of Connected Load—Appliances in per Cent Density

	Electric Irons	Curling Irons	Waffle Irons	Toasters	Percolators	Grills	Water Heaters	Vacuum Cleaners	Disk Stoves	Wash. Mach. Motors	Sew. Mach. Motors	Radiant Heaters	Fans	Heating Pads	Piano Motors	Victrola Motors	Vibrators	Violet Ray	Refrigerators	Battery Chargers	Miscellaneous
Two-Story Houses																					
1. Darrah St.	95	11	4	20	6	2	..	87	2	45	4	9	15	..	..	..	..	..	..	..	..
2. So. Bonsall St.	76	6	2	3	2	..	..	56	2	20	6	..	6	2	..	..	2	..	..	..	..
3. Dexter St.	77	2	..	14	2	..	..	58	5	7	..	..	..	..	2	..	..	..	..	..	..
4. Johnston St.	85	4	0.5	24	7	..	..	68	1	32	2	2	0.5	0.5	..	0.5	1	0.5	..	..	..
5. E. Price St.	90	19	4	42	14	4	2	78	1	32	8	7	10	1	..	1	..	..	..	8	..
6. Colwyn St.	93	..	..	57	7	..	..	79	7	29	7	..	..	..	..	..	..	..	..	7	..
7. So. Wilton St.	92	11	3	28	6	3	..	86	..	45	3	5	5	3	..	..	..	..	..	5	..
8. Roosevelt Blvd.	87	4	2	21	..	..	..	81	..	34	..	13	2	2	..	..	..	4	..	..	..
Three-Story Houses																					
9. Jerome St.	86	2	..	43	9	..	..	86	..	25	9	2	..	..	..	..	..	..	..	..	..
10. Rochelle Ave.	90	6	4	34	5	2	1	78	..	38	5	14	5	3	2	1	..	1	..	..	1
11. So. 48th St.	102	20	16	53	4	2	2	89	2	13	13	18	9	2	..	..	..	..	2	4	7
Apartments																					
12. Pine St.	77	17	13	48	9	17	4	48	..	4	..	4	..	..	..	..	..	..	..	4	..
13. N. 33rd St.	77	..	..	29	..	..	..	70	..	..	..	..	6	..	..	..	..	..	..	..	..
Detached Houses																					
14. N. 12th St.	100	8	16	40	16	..	..	88	4	36	20	4	4	..	..	..	..	..	..	..	..
15. Sherwood Ave.	106	17	17	28	17	..	..	67	..	50	6	33	..	..	..	..	..	6	..	..	..
16. Pelham Rd.	116	18	11	40	26	8	..	84	.5	40	13	50	26	11	..	..	3	..	11	..	..
Grand average	89	9	4	30	8	2	0.6	75	1	32	5	8	5	1	0.3	0.3	0.4	0.4	0.8	2	0.4

Table III—Load Factor of Appliances

Appliance	Kw.-Hr. Consumed per Appliance per Week	Demand, Watts	Load Factor During Week of Test, Per Cent
Electric iron	1.89	549	2.045
Toaster	0.37	497	0.443
Vacuum cleaner	0.11	168	0.389
Washing machine	0.44	202	1.295
Sewing machine	0.09	61	0.878
Disk stove	1.67	591	1.682
Percolator	0.64	399	0.943
Waffle iron	0.57	560	0.606
Grill	0.71	506	0.835
Battery charger	1.15	50	13.680
Heater	2.44	597	2.452
Bottle warmer	1.47	438	1.997
Oil furnace	3.12	102	18.200
Curling iron	0.22	100	1.309
Ironer	0.83	250	1.977
Chafing dish	0.20	200	0.595
Refrigerator	8.83	285	18.440

Table IV—Appliance Consumption per Annum

	Estimated Annual Consumption, Kw.-Hr.	Estimated Annual Load Factor, Per Cent
Electric iron	98.3	2.045
Toaster	19.8	0.443
Vacuum cleaner	5.7	0.389
Washing machine	22.9	1.295
Sewing machine	4.7	0.878
Disk stove	86.8	1.682
Percolator	33.3	0.943
Waffle iron	29.7	0.606
Grill	36.9	0.835
Battery charger	44.8	10.280
Heater	32.2	0.817
Bottle warmer	31.1	0.998
Oil furnace	66.0	9.100
Curling iron	11.4	1.309
Ironer	43.2	1.977
Chafing dish	10.4	0.595
Refrigerator	460.0	18.440

ment and service. Continuous commercial and educational effort is needed in order to improve the conditions revealed by examination into the circumstances mentioned. As far as new houses are concerned, a demand upon the part of purchasers for refrigerators and ranges of the electric type installed and financed as part of the building seems the only solution to this problem. Rates that offer inducements for the use of such equipment must be put in effect as a preliminary step to bring about this development.

Opportunities in Lighting Discussed

The increase of lighting intensities in the home, generally believed to be too low, has been advocated as a means of improving the residence business situation. The results of a very large number of surveys in Philadelphia fail to reveal such an extraordinary opportunity in this direction as commonly indicated. The improvement of lighting conditions along the lines of utility and beauty does without doubt offer a large field for commercial effort. Refixturing and portable lamp campaigns seem the most obvious directions for immediate results along this line. Proper consideration must be given to the budget feature, already mentioned, as well as to the fact that the economics of any given situation must be preserved. It is a disadvantage to the customer and of no advantage to the utility to simply multiply lighting wattage installed beyond the point where proper illumination effects are obtained.

The sale of appliances and the encouragement of their use have been widely advocated as true remedies for all the real and imaginary ills of the residence business. With the lapse of time and the belief that conditions are still far from satisfactory, the problem of improving the residential business is again being restated. From the progressive data gathered in Philadelphia several facts may be indicated with relation to the real effect of the appliance load upon the residential load factor and income. Possibly the most important of these deals with the relative value of household appliances to the utility and to the customer.

Of the ordinary apparatus found in the average household the electric iron is the only real load and load factor builder. The rest of the devices ordinarily found—vacuum cleaner, toaster, percolator, sewing machine, even the washing machine—offer, individually, great aid to the user, but the amount of current they add to the residence consumption helps, but does not solve, the existing situation.

Domestic refrigeration, where introduced, makes a radical change in the residential situation. The annual load factor is immediately improved and the customer feels the economic benefit in total expenditure. The electric range, where properly used, gives every indication of being the device that must be taken hold of earnestly by the utility. Very careful studies of this situation are now being carried on. The rate structure is now in shape to handle the range situation, and we have firm faith in the future development of this class of service. The fundamentals of this line of devel-

Table V—Summary of Appliance and Lighting Consumption

Group	Type Residence	Appliance Consumption, Per Cent	Lighting Consumption, Per Cent	Appliances per Customer
1	Two-story row	23.3	76.7	1.70
2	Two-story row	21.6	78.4	2.98
3	Two-story row	14.3	85.8	1.80
4	Two-story row	21.4	78.6	2.27
5	Two-story row	23.3	76.7	3.30
6	Two-story semi-detached	25.0	75.0	2.93
7	Two-story semi-detached	16.2	83.8	2.51
8	Three-story row	20.8	79.2	3.79
9	Three-story row and semi-detached	19.1	80.9	2.88
10	Three-story row and semi-detached	23.2	76.8	3.60
11	Apartments	14.0	86.0	2.43
12	Apartments	10.9	89.1	1.82
13	Detached	19.1	80.9	3.36
14	Detached	12.3	87.7	3.44
15	Detached	17.7	82.3	4.60
Average for each type of residence:				
	Two-story row	20.8	79.2	2.49
	Two-story semi-detached	21.1	78.9	2.76
	Three-story row and semi-detached	21.4	78.6	2.99
	Apartments	12.1	87.9	2.17
	Detached houses	15.9	84.1	3.96
Average for all residences		17.9	82.1	2.74

Table VI—Summary of Kilowatt-Hour Consumption

Group	Average Kw.-Hr. per Month During Test	Average Kw.-Hr. per Month During Year
1 Two-story row (66)	37.8	24.9
2 Two-story row (81)	32.3	23.3
3 Two-story row (72)	40.2	23.9
4 Two-story row (279)	39.4	25.2
5 Two-story row (159)	39.3	26.4
6 Two-story semi-detached (101)	65.8	37.5
7 Two-story semi-detached (64)	50.5	43.7
8 Three-story row (65)	46.1	35.4
9 Three-story semi-detached (112)	48.1	36.3
10 Three-story row and semi-detached (60)	77.6	41.7
11 Apartments (29)	*58.1	*38.9
12 Apartments (21)	*85.6	*59.1
13 Detached (41)	79.5	50.8
14 Detached (21)	109.4	76.2
15 Detached (47)	126.3	90.0
Average for each type of residence:		
Two-story row (657)	38.4	24.7
Two-story semi-detached (165)	70.7	41.2
Three-story row and semi-detached (237)	58.1	37.5
Apartments (50)	*69.8	*47.4
Detached (109)	105.6	72.6
Average for houses in all groups (1218)	53.3	34.6
Average for all rate "A" customers	....	29.8

Figure in parentheses indicates number of houses.
*Includes hall lights prorated among customers.

opment have been so fully set forth in recent articles in the ELECTRICAL WORLD that it is not necessary to repeat them, but rather to affirm their value.

CONDITIONS IN 1915 COMPARED

In connection with the above statements it may be of interest to consider the present situation as compared with that of 1915 in different classes of residences.

A standard method of test and analysis was developed a few years ago that provides a complete cross-section of the residential market and insures sufficient accuracy to render the results obtained of definite and practical value. Groups of residences, conforming to each of the six prevailing types of homes to be found in Philadelphia, are segregated on separate secondary feeders. Preliminary records of connected load, including both lamps and appliances, are secured in full detail. Graphic meters are installed for a period of one week in certain houses that are selected from each group as being representative of the general average. It is, of course, essential that a sufficient number of houses be surveyed and tested in order that a dependable average can be secured.

The tabulated data given in Table I, secured as a result of a study made in November and December of 1925, may be of some general interest.

After a careful inspection of the conditions in Philadelphia, it was found that almost all of the homes will fall under one of the following types: (1) Two-story row houses; (2) two-story semi-detached houses; (3) three-story row houses; (4) three-story semi-detached houses; (5) apartments; (6) detached houses.

The groups of houses that answered the requirements were isolated on the secondary service and at the very outset a schedule of tests was made up so as to include different type houses during each week of test so that the effect of the seasonal variation on demand will be the same for all the classes.

SURVEY OF CUSTOMERS

The addresses were turned over to the accounting department, which furnished the customers' names and bills for the past year. Letters were sent to the customers explaining the purpose of the survey to be made and asking them if they would give the desired information to the representative of the company who would call a day or two later. Members of the survey department had been thoroughly drilled as to the procedure to be taken in approaching the customers and in getting the desired information concerning the customer's installed lighting and appliance load. They were provided with cards, as shown in Fig. 1, to be filled out on the premises.

Out of the 1,218 customers who were in the groups isolated on the secondary wires, the survey men succeeded in securing the lighting and appliance loads of 942.

MEASUREMENT OF DEMAND

Curve-drawing meters were installed in the premises of ten representative customers of each group. The data obtained from each test were as follows:

1. Kilowatt-hour consumption of each individual customer during the week. This was taken from the regular kilowatt-hour meter installed in the customer's premises.
2. A curve of the customer's consumption, kilowatts in some cases and amperes in others, for one week, with notation made on the chart each day as to the particular appliances used by the customer on the day preceding.
3. Ammeter chart showing the total consumption of the group of customers for the week of the test.

THE RESULTS OBTAINED FROM TESTS

The results obtained were:

1. Annual kilowatt-hour consumption of different types of residences.
2. Density of various appliances in different types of residences.
3. Installed lighting load in various rooms for different types of residences.
4. Maximum demands on the transformer.
5. Maximum demands on the meters.
6. Diversity factor among customers of each group.
7. Per cent consumption due to appliance load.
8. Per cent consumption due to lighting load.
9. Average demand of various appliances.
10. Average consumption of each appliance.
11. Load factor of appliances.
12. Load factor of residences.
13. Load factor of transformers.

A few of the tabulated results are given in the accompanying tables.

CHARLES J. RUSSELL *says:*

IT IS believed in Philadelphia that the residence field offers the greatest opportunity for development presented by any existing class of business.

Of the ordinary apparatus found in the average household the electric iron is the only real load and load factor builder.

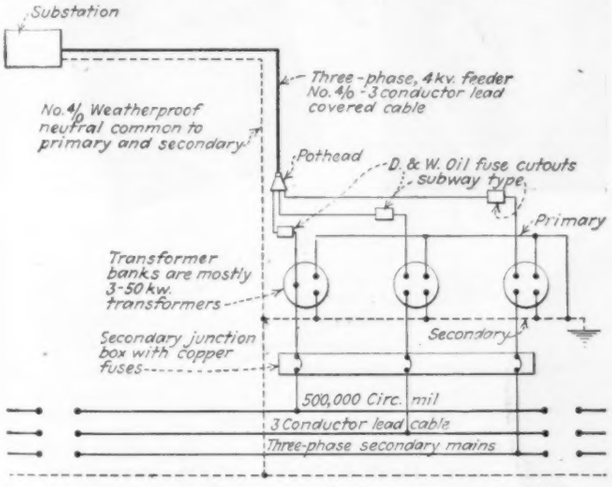
Domestic refrigeration, where introduced, makes a radical change in the residential situation. The annual load factor is immediately improved and the customer feels the economic benefit in total expenditure.

The electric range, where properly used, gives every indication of being the device that must be taken hold of earnestly by the utility.

Sacramento A.-C. Underground System

Network System Used in Restricted Area Because of Historical Background—Lamp Voltage 120 and Motor Voltage at 208—Experiences and Details of Installation

FOR MORE than twenty years the Pacific Gas & Electric Company has had a four-wire, three-phase, 120/208 volt, alternating-current distribution system in Sacramento, Cal., a city of about 100,000 population. When the wires were placed underground in 1912, the same system was of practical necessity installed, because buildings were wired for this type of service and motors and other equipment in operation had to be supplied with the same type of service unless the company went to considerable expense to make alterations. Sacramento has thus grown up with the system and


Substation
Three-phase, 4 kv. feeder No. 4/0 - 3 conductor lead covered cable
No. 4/0 Weatherproof neutral common to primary and secondary
Pothead
D. & W. Oil fuse cutouts subway type
Primary
Transformer banks are mostly 3-50 kw. transformers
Secondary junction box with copper fuses
Secondary
500,000 Circ. mil
3 Conductor lead cable
Three-phase secondary mains

CONNECTION SCHEME OF SACRAMENTO, CAL., 120/208-VOLT, FOUR-WIRE, THREE-PHASE UNDERGROUND SYSTEM OF PACIFIC GAS & ELECTRIC COMPANY

during the fourteen years the underground system has been in operation no particular trouble has been experienced.

The area served comprises forty 400-ft. blocks, ten blocks long by four blocks wide, with a total load of 3,300 kva. fed by three 2,300/4,000-volt, four-wire, three-phase primary feeders supplying the district. There is a total connected motor load in the district of 2,400 hp., with 15 hp. as the maximum size of motor. The motor load is made up largely of small miscellaneous motors such as is found in the average business district of a city of this size. Elevators are practically all served from a direct-current system.

The lighting voltage used on the system is 120 volts, which gives 208 volts for three-phase power when the transformer secondaries are Y-connected. All of the motors are of standard 220-volt rating, and no special trouble has been experienced with motors over-heating except in cases where the motor has been of too low rating to carry the load imposed. The only complaints have come from installations where the motor would otherwise have been too small.

There is about 150 hp. in heating load such as bakeries, etc., and the only precaution necessary has been to see that the heating elements are rated at 210 volts instead of 220 volts. The most satisfactory method of serving heating load has been to require the customer to purchase elements rated at 110 volts instead of 210 or 220 volts and to Y-connect these for three-phase, four-wire service. If there are only two such 110-volt heating elements, they are connected between neutral and two of the phase wires to give as nearly a balanced load as possible.

The scheme of connections used, size of wire, protection, etc., is shown in the accompanying illustration. From this it will be seen that the feeders from the station consist of a No. 4/0, three-conductor, lead-covered cable. A No. 4/0 weatherproof neutral common to both primary and secondary and grounded at each transformer bank is carried back to the substation, where it is again grounded. Transformer banks for the most part consist of three 50-kw. transformers with the primaries and secondaries both Y-connected with neutrals grounded. Transformer banks are protected on the primary side by D. & W. oil fuse cutouts and on the secondary by copper link fuses in junction boxes of P. G. & E. design and manufacture. Usually there is one transformer bank per block feeding three-conductor, 500,000-circ.mil, lead-covered secondary mains, although secondary mains as small as No. 4/0 are used. The No. 4/0 weatherproof neutral is a metallic bus throughout the system, but no attempt is made to bus the secondary mains from different transformer banks to form a network. All secondary mains, however, are phased out so that adjacent transformer banks may be tied together in case it is desired to take a bank out of service for any reason. With the comparatively small maximum size (15 hp.) of motor on the system and with the heavy secondary mains used, no serious trouble has been experienced with poor lighting voltage regulation. The success of such a system obviously rests upon the relationship of the power to the lighting load and upon the size and characteristics of the motors. For large motors with starting characteristics that would cause poor lighting voltage regulation a separate transformer bank is installed.

Metering has presented no serious problems, as a three-phase meter or two or three single-phase meters are suitable for metering any type of load.

No Serious Difficulties Encountered

Although experience with the Sacramento system has not indicated any serious difficulties, it should be borne in mind that the 120/208-volt, four-wire system is primarily applicable and will prove workable only under such conditions as exist in Sacramento, where the power load is incidental to the lighting and is of small magnitude. One important conclusion to be drawn from the Sacramento experience is that 120 volts is thoroughly satisfactory for lamps, whether supplied from a single-phase secondary or a three-phase secondary either star or delta connected. The engineers of the Pacific Gas & Electric Company are unanimous in their approval of the use of 120 volts for lamps, and this voltage is now standard in San Francisco as well as Sacramento.

One of the chief objections to the 120/208-volt, four-wire, three-phase system is the non-standard motor voltage supplied, and in the opinion of S. J. Lisberger, chief of the division of electric distribution and steam engineering of the company, there are many advantages to the industry in staying with present standard motor voltages which engineers should not overlook in considering alternating-current networks.

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Business Growth in Four Cities

The Rate Factor in Load Building—Comparisons of Rates, Usage and Revenues—Importance of the Price Incentive—Trend Toward Lower Energy Charges Through Use of Compound Rates—Influence of Rate Structures

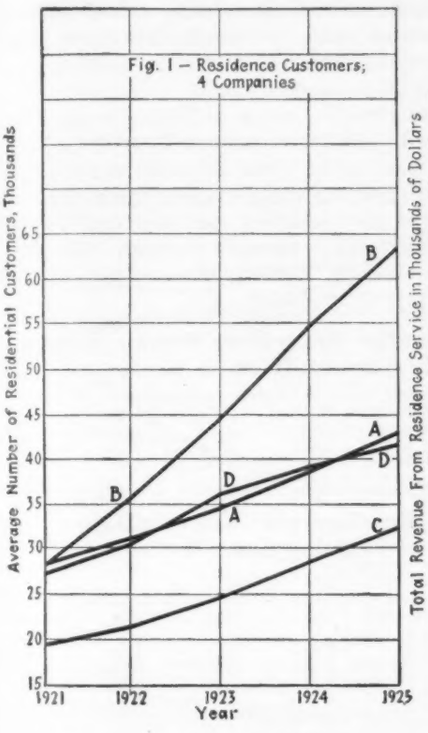


FIG. 1—GROWTH IN RESIDENCE CUSTOMERS, 1921-25

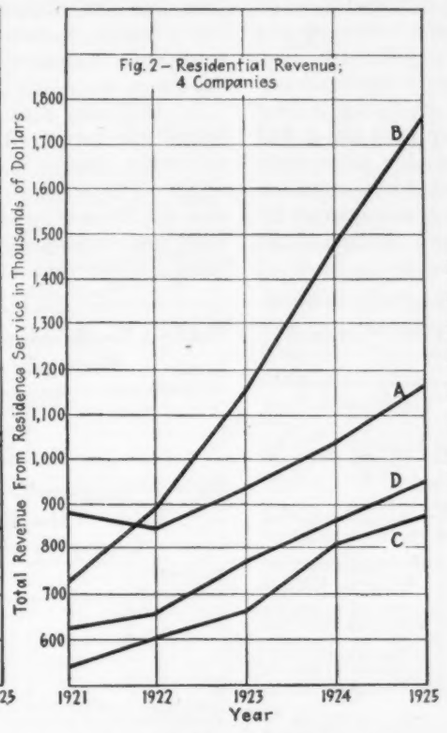


FIG. 2—REVENUE FROM RESIDENCE SERVICE, 1921-25

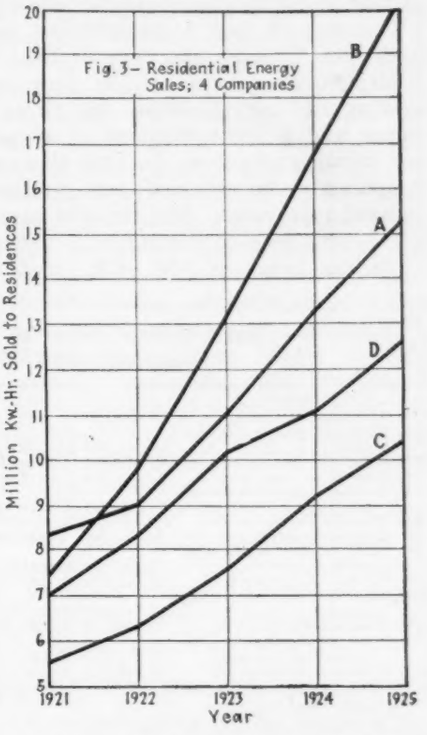


FIG. 3—ENERGY SALES TO RESIDENCES, 1921-25

AN ERA of searching economic analysis has lately arrived in the central-station industry, but the significance of its demands is not yet fully appreciated by many operating companies. From pioneer days, engineering and commercial progress has been based upon the study of costs and revenues, but today both broader and deeper analyses are in order. The pressure upon the invested dollar for more intensive use is putting new emphasis upon values, calling for a more intelligent, a more scientific approach to the problems of load development in general and in particular to the influence of rates upon the use of service. In this article the growth of business in four Eastern electric utilities has been studied over a five-year period with the objective of attaining at least a preliminary idea of the sort of rates most likely to be effective in encouraging a well-balanced development of profitable service.

The four companies, A, B, C and D, all serve attractive cities with diversified industries, prosperous communities of high cultivation, "light and leading." None of these cities is of the so-called "mill-town" or "one-industry" type. Manufacturing is active in each—vital, in fact, to the local business development. Commerce, the arts and education flourish in each place. The standards of living and business viewpoints conduce to a liberal and increasing use of electricity. Each central station is interconnected with others through transmission lines of regional importance, and the influence of interconnection upon the investment and costs of the several companies is steadily increasing in importance. These cities are near one another, so the effects of climate and regional habits are about the same.

Table I gives various data indicating the size and comparative service volumes of the four companies in 1925.

The number of total customers in companies A, C and D is closely comparable, but is naturally greater in B, which serves double the population reached by any of the other companies. Company A has two steam-generating stations, one of which is held mainly in reserve, and company D serves an extremely compact territory and but one town outside its central city. It is noteworthy that the development of residential business is one of the most important phases of service in all four companies, though company C does not merchandise appliances. In all the companies the revenue closely approaches or somewhat exceeds $1,000,000 a year from household use of electricity. In none have the possibilities of electric cooking and refrigeration been extensively developed, but rapid strides are being taken here in companies A and B, and companies A and D are making fine headway in building their in-

dustrial electric-heating loads. Companies A and B are extremely important from the steam relay standpoint in connection with hydro-electric systems in contact with them, and close co-operation is maintained in the interchange of energy, the flow naturally depending directionally to a large extent upon water conditions.

RESIDENTIAL RATE DEVELOPMENT

The most prominent phase of rate development in these companies in the 1921-1925 period is the recognition by their managements of the value of some form of rate to encourage residential use of electricity.

Company A had a straight-line meter rate of ten cents per kilowatt-hour net in use in 1921 and also a straight-line meter rate of four cents for cooking, heating and refrigeration, the latter carrying a fuel clause and a night discount of 40 per cent on a $20 per month guarantee. In 1922 these meter rates were temporarily discontinued and replaced by Hopkinson demand type rates. The ten-cent rate was replaced by a two-part rate consisting of a demand charge of 60 cents per year per 100 sq.ft. of floor area, plus an energy charge of 5.5 cents per kilowatt-hour. The cooking, heating and refrigeration rate adopted was of the block type and required an electric range in the installation. It carried a demand charge of $1.44 per year per 100 sq.ft., two block charges and an energy rate of two cents. The change from the meter rate to the two-part rate was achieved by a notable campaign of publicity with the offer to restore the straight-line rate after a year's trial, but only 0.2 per cent of the residence customers sought to change back. The change actually "put a power rate in the home," encouraged the liberal use of electricity, raised many unprofitable customers into the profitable class and practically standardized the single meter installation for the great majority of residences.

In 1923 the straight-line meter rate was made optional as promised, but few returned to it. The minimum charge was raised from 25 cents per month to $1. The cooking, heating and refrigeration straight-line meter rate was also restored, and the four rates were maintained with minor changes through 1924 and 1925, except that on July 1, 1923, the energy charge

Table I—Characteristic Data of Four Central Stations, 1925

Company	A	B	C	D
(1) Total number customers	55,184	92,572	42,346	51,323
(2) Plant and property investment	$20,662,800	$26,192,000	$9,771,000	$6,216,000
(3) Population served	200,000	426,000	161,000	197,500
(4) Generating plant, kva	97,500	118,000	58,740	57,000
(5) Average number residence customers	42,959	63,343	31,780	41,642
(6) Total kilowatt-hour sales	152,463,821	236,033,557	75,966,694	92,067,706
(7) Total revenue from (6)	$4,941,541	$6,488,078	$3,108,938	$3,219,584
(8) Total kilowatt-hours sold, residential	15,282,346	20,187,962	10,465,027	12,628,325
(9) Total revenue from (8)	$1,160,358	$1,743,636	$873,506	$947,555
(10) Total kilowatt-hours sold, power	61,140,058	108,864,667	41,797,482	51,479,591
(11) Total revenue from (10)	$1,358,222	$2,287,260	$1,041,642	$1,053,402
(12) Total kilowatt-hours commercial lighting sales*	21,233,746	38,600,547	17,806,235	18,987,943
(13) Total revenue from (12)*	$1,349,505	$2,002,715	$1,103,238	$1,107,834

* Includes street lighting.

Table II—Use per Average Residential Customer

	1921	1922	1923	1924	1925	Per Cent Gain 1921–1925
A	294	287	317	342	357	21
B	259	273	294	307	319	23
C	289	302	306	323	330	14
D	257	271	286	283	303	18

Table III—Average Revenue Residence Service, Cents per Kilowatt-Hour

	1921	1922	1923	1924	1925	Per Cent Decrease 1921–1925
A	10.7	9.4	8.5	7.96	7.6	29
B	9.85	9.28	8.84	8.74	8.65	12
C	9.75	9.51	8.8	8.78	8.35	11
D	8.87	7.95	7.66	7.80	7.48	4.4

Table IV—Average Residential Bill

	1921	1922	1923	1924	1925	Per Cent Change 1921–1925
A	$31.40	$27.10	$27.10	$26.80	$27.00	—14.0
B	25.60	25.30	26.00	26.80	27.60	+ 7.8
C	28.20	28.70	27.00	28.30	27.60	— 2.1
D	22.75	21.55	22.00	22.05	22.80	+ 0.2

Table V—Residential Heavy-Duty Service, Kilowatt-Hours and Revenue

	1921		1922		1923		1924		1925	
	Kw.-Hr.		Kw.-Hr.		Kw.-Hr.		Kw.-Hr.		Kw.-Hr.	
A	668,943	$34,752	606,953	$28,991	789,949	$34,252	1,083,186	$44,641	1,600,559	$67,732
B	362,129	9,459	521,104	13,822	644,890	18,718	813,343	26,314	925,996	28,488
D	553,546	20,263	738,222	24,805	885,957	32,458	794,355	31,916	901,912	35,466

Table VI—Residential Heavy-Duty Service Average Rate per Kilowatt-Hour in Cents

	1921	1922	1923	1924	1925
A	5.2	4.78	4.43	4.11	4.23
B	2.61	2.66	2.82	3.24	3.08
D	3.66	3.36	3.66	4.02	3.93

Table VII—Revenue per Kilowatt-Hour Commercial Lighting Sales in Cents

(Street lighting included)

	1921	1922	1923	1924	1925
A	7.05	6.85	6.7	6.7	6.35
B	5.55	5.38	4.9	5.22	6.9
C	6.35	6.44	6.25	6.36	6.2
D	5.43	5.71	5.85	5.96	5.84

Table VIII—Dollars Total Revenue per Capita

	1921	1922	1923	1924	1925
A	$19.50	$22.40	$25.40	$24.40	$24.70
B	12.80	13.70	15.60	15.30	15.25
C	14.30	16.90	18.20	19.20	19.30
D	12.60	13.95	16.30	15.20	16.50

Table IX—Total Revenue, Sales and Population Served

	A	B	C	D
Total Sales Dollars				
1921	$3,421,107	$4,744,650	$2,080,787	$2,309,665
1922	4,050,861	5,228,985	2,523,097	2,616,671
1923	4,758,963	6,216,978	2,973,133	3,106,239
1924	4,751,240	6,306,862	3,014,302	2,975,294
1925	4,941,541	6,488,078	3,108,938	3,219,584
Population Served				
1921	175,000	369,317	145,675	183,394
1922	181,000	383,450	149,438	186,911
1923	187,000	387,583	153,201	190,428
1924	194,000	411,718	156,964	195,545
1925	200,000	425,851	160,728	197,462
Total Kilowatt-Hours Sold				
1921	77,185,381	206,193,716	44,823,105	54,013,258
1922	111,582,041	254,784,590	74,459,777	70,957,329
1923	159,686,324	328,889,955	84,238,460	87,365,290
1924	143,844,287	250,441,123	85,270,643	78,773,543
1925	152,463,821	236,033,557	75,966,694	92,067,706

on the two-part residential rate was reduced to five and one-half cents per kilowatt-hour. Another residential light and cooking, combination flat and meter rate was established in 1925. It requires a range, refrigerator or other large consuming device in the installation, has a demand charge of 96 cents per 100 sq.ft. per year and a four-cent energy charge. Free renewals of lamps were common to most of these schedules.

Company B had three rates of interest to residential users in 1921. These were a general lighting, two-charge rate, with a customer charge of $6 per year and an energy charge of seven and one-half cents net and a fuel clause of one mill per kilowatt-hour figured on each dollar above or below an $8 base; a general

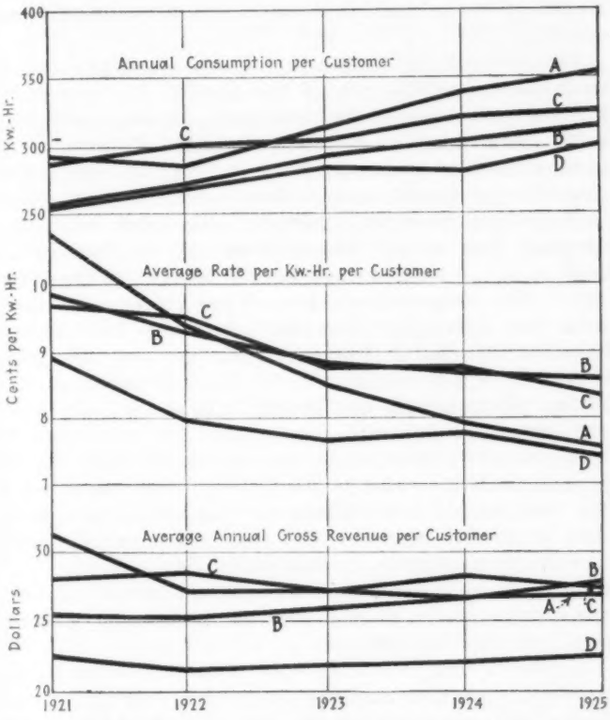


FIG. 4—GROSS REVENUE, AVERAGE RATE AND KILOWATT-HOURS PER CUSTOMER, 1921-25

lighting, optional block meter rate, first 500 kw.-hr. ten cents, minimum charge $2.50, and a fuel clause as before; and Hopkinson step and block cooking and heating rate. The last started with a demand charge of $2 per month for 5 kw. or less ($3 for the first 7 kw. plus $1 per kilowatt for excess) plus one and one-half cents energy charge. In 1922 the energy charge on the first-named rate was cut to seven cents, and the rates remained the same through 1923-1925, barring a change in the demand section of the Hopkinson step and block cooking and heating rate in 1924, installations of 5 kw. or less being scheduled at $42 per year instead of $24, with other modifications, but the same energy charge of one and one-half cents. No discounts or free lamps were allowed in any of these schedules.

Company C began 1921 with a straight-line meter rate of ten cents per kilowatt-hour net for residential lighting and general commercial use and a minimum charge of $8 per year. No free lamp renewals were given. This rate also included a seven-cent bracket for charitable institutions and hallways; a six-cent rate for electric signs and for heating and cooking apparatus on a separate meter. In March, 1921, the heating and cooking rate was reduced to four and one-half cents with a minimum of $6 per year per kilowatt connected and a minimum bill of $8 per meter. No changes of consequence were made in 1922-1924, but on Jan. 15, 1925, the maximum lighting rate was cut to eight and one-half cents. One or two other slight changes were made at this time, including the establishment of a four and one-half cent rate for electric refrigeration wired in conduit on separate meter.

Eight cents net was charged for residence lighting by company D in 1921, the minimum charge being $9 per year. No free lamp renewals were in effect. A meter block rate was also in use for residence heating and cooking. This quoted eight cents net for the first 10 kw.-hr. and three cents for the excess. In 1924 the straight-line residence rate was cut to seven and one-half cents, and the residence heating and cooking rate above mentioned was modified to schedule the first block of 20 kw.-hr. at seven and one-half cents, raising the excess to four cents, increasing the minimum charge to $12 per year and allowing no lighting on this rate. In that year a new rate of the demand type based on the number of rooms in a residence was established. This charged seven and one-half cents net for the first block and three cents for the excess. The first block was determined by a schedule of from six to fifteen rooms, the kilowatt-hours to be charged at the first block rate being 30 for a six-room house and 112 for fifteen rooms. For each room in excess of fifteen the company adds 11 kw.-hr. to the first block. Halls, closets, unfinished rooms, etc., are not counted, but rooms in garages and stables count if supplied through the residence meter. A minimum charge of $2 per month applies up to and including seven rooms, and this increases to $3.50 for fifteen rooms and above.

GROWTH OF RESIDENTIAL BUSINESS

In examining the accompanying charts, showing the development of residential service in these companies during the past five years, it should be borne in mind that many factors control the use of electricity in the home. Among these are the size of the monthly bill, the existence of a rate with a "come-along" feature in the shape of an energy charge encouraging liberal use, the general prosperity of the community, national and local advertising of the low cost of electricity, cheapness of light and of energy for socket appliances, psychology of a low energy rate, existence of daylight saving, climatic conditions, latitude, activities of electrical retailers and of manufacturers, national and local advertising of well-appointed electrical homes and devices to enrich the comfort and convenience of life, alertness of electrical appliance repairers, and the use of radio sets. It so happens that each of the four cities in this study is the site of a high-grade radio broadcasting station, and although there are many local differences in these towns, their general caliber is sufficiently similar to justify some degree of comparison of their use of electricity, particularly in the home.

Fig. 1 shows the growth of residence customers over the five years. These increased by 121 per cent in company B, by 51 per cent in A, by 52 per cent in D and by about 66 per cent in C. The gain of B is in part due to the cultivation of relatively unsaturated territory and in part to a most vigorous and well-conducted in-season-and-out campaign for house wiring in co-operation with the members of the local electrical

league, to say nothing of the fine merchandising efforts of this central station. In companies A and D the saturation point in houses wired is close at hand, and sales effort is necessarily most active in developing load on existing residential circuits. Merchandising of appliances is ably handled in each company. Company C has a habit of "consolidating its gains" and keeping its customers, once secured, and considerable new building has been of value to it. Although this company does not merchandise, it is a warm friend of local electrical dealers, and has spent money many times to promote the sound development of its community electrical.

The growth in residential revenue of the four companies is shown in Fig. 2, and Fig. 3 shows the increase in energy sales to residences. Since company C serves the smallest of the four cities, it naturally has the lowest residential service sales volume. It is significant that the rate of growth of energy sales to residences has been most rapid in A among the three companies more comparable in size. In Fig. 4 it will be noted

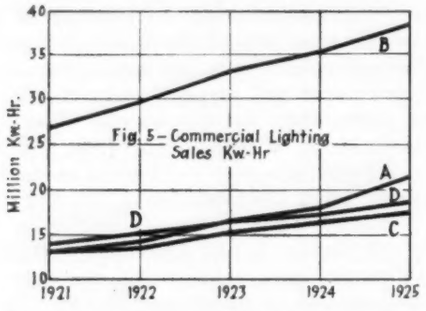


FIG. 5—ENERGY SALES TO COMMERCIAL LIGHTING CUSTOMERS, 1921-25

that A has given its residence customers the most rapid reduction in the average rate per kilowatt-hour in the five-year period and the greatest increase in consumption, but it does not have the rate of increase in total revenue that company B has. Tables II, III and IV give the data from which Fig. 4 was plotted to give basic unit comparisons.

We now are in a position to draw a few conclusions in regard to residence rates. Each of these companies is ably managed and has conspicuously good public relations. It is hard to escape the conviction that company A's success in "selling" its public the idea of accepting a combination flat rate and relatively low energy charge has been a vital factor in its accelerating use per residence customer. Three years' experience has indicated that a compound rate with comparatively low energy component is hard to beat, if it is properly "sold" to the public. Ask a man on the street in A what the lighting rate now is in his town and he will tell you "Five and one-half cents." The flat part or area section makes little impression on his memory. Here is a point in customer psychology, and as a matter of fact, the average rate has gone down so far in all these companies in five years, as Fig. 4 shows, that good measure has been given in every one. Company D has the lowest rate with a short primary block and a low follow-on rate, yet it has not taken commercial advantage of its fine rate structure to push business rapidly.

But a glance at Fig. 4 shows that, measured by the three major standards—rate, consumption and total revenue per customer—a fine condition exists for company B. It has the highest average rate, the highest gross revenue and the third highest consumption. And more important, all three items are going in the proper direction. Also it must be remembered that company B has done this job while increasing the number of its residence customers 121 per cent during the period. Despite dilution there was real commercial selling as well as a rate influence at work to maintain the consumption on the upgrade during the five-year period. Company C has a lower rate and a higher consumption, yet the gross revenue trend is in the wrong direction. This may or may not be accounted for by the fact that this company alone uses a straight-line rate.

The moral of the curves in Fig. 4 is that rates and commercial efforts must combine to make an increasing consumption and gross revenue while the rate decreases. Unless all three conditions exist, no real prosperity can continue.

Company D has an ideal inducement type of rate that has been "the talk of the family" in its locality for years because of its comparatively low residential rate. There was a meter block rate of three cents beyond the first 10 kw.-hr. back in 1921, but such a fine rate alone does not seem to have been very influential in building the total residence sales, and lately the company has raised this cooking rate to four cents. Only a few customers are as yet served on the room rate. The comparatively low energy charge this company has maintained for years, however, has unquestionably stimulated business steadily, and all three checks show a strong condition with indications of still better. Company B has grown so fast that one could not expect its average consumption per residence to keep pace with more highly saturated territory for the present, but measured by all checks, it has done about the best job of intensifying service and at the same time increasing revenue. Company C has perhaps been a little conservative commercially, for though it is gaining in per customer use right along, the revenue per customer is on the decrease despite a rapid decrease in its straight-line rate.

Tables V and VI show the growth in heavy-duty residential service in three companies over five years. These data, when compared with Figs. 2 and 3, indicate that although specially designed rates to encourage large cooking and heating service in substantial residences have their place (and result in fine percentage increases), we must again return to the so-called ordinary user and fit our rate to his conditions if we are to attract sufficient patronage to make a real bulge in the total sales curve. In the last analysis low bills or better, increased service for each dollar of revenue tell the story. Fig. 4 shows the trend toward greater use as the average price decreases.

Opinions differ as to the best form of combination flat and energy rate to adopt, but either a room rate or an area rate has offered a seemingly satisfactory solution for some utilities if it is accompanied by a sufficiently low energy charge to establish a comparatively low average rate. If a block rate is used, the primary block should be narrow and there should be very appreciable rate reductions in the follow-on blocks. This type of rate structure is more generally favored. The general effect desired is to collect investment and customer charges quickly and then give a low follow-on rate to induce usage. The area rate in this study perhaps had some advantage in period of use, but it seems clear that whether the rate average be reached through a

block demand, an area demand or a room demand count plus an appropriate energy charge, the ultimate test of success must be a continued increase in the revenue per customer, a continued decrease in rate and a continued increase in use. Without adequate publicity and vigorous sales activity a residence rate schedule cannot be expected to attain its maximum usefulness, and once more let the importance of "selling the rate" to the customer be urged as a vital necessity. The single meter installation helps in this, and the trend toward it is unmistakable. The potential use of electricity in the modern home is many times the present development, and rates of the "protective" type must give way to rates of the "promotional" type if the industry is to serve with vision and with the prosperity warranted by its possibilities.

COMMERCIAL LIGHTING AND POWER DEVELOPMENT

Investigation of the commercial lighting and power business of the foregoing companies thus far does not disclose any marked intercompany comparative relationship between rate structures and load development. Space will not permit detailing these rates, but out of a long study of conditions in each company it may be said that the form of the rate is influential in enabling business to be secured in the first place. The total cost of service is more interesting to the customer, with relatively few exceptions, than the form of the rate schedule. In both the commercial lighting and power fields these companies are trending toward the wider use of a block meter rate of the combination demand and energy charge type. A comparatively simple schedule has its advantages from the standpoint of reaching the customers' understanding. The inclusion of low brackets in the energy charge section of the rate is highly desirable, even though many customers may be unable to attain these.

Fig. 5 shows the growth of commercial lighting business in the four companies in five years in energy sold, and Fig. 6 gives the revenue obtained from this business in each company. The average rate per kilowatt-hour is shown in Table VII.

The growth of this business appears consistent, and the block meter rates yield attractively low energy charges and very moderate average prices per kilowatt-hour. It is a fair statement that the various commercial lighting combination demand and energy charge rates used by these companies are giving good service. There is a general tendency to include fuel clauses in the commercial lighting rates, and the fluctuations in the price of fuel tend to make the trend of these rates somewhat uneven. There is a downward drift, however, in these rates, which sooner or later results in increased use of service. Energy sales for commercial lighting increased in company A from 13,051,970 kw.-hr. in 1921 to 21,233,746 kw.-hr. in 1925; in company B from 26,794,484 kw.-hr. to 38,600,547 kw.-hr.; in company C from 12,898,503 kw.-hr. to 17,806,235 kw.-hr., and in company D from 14,085,467 kw.-hr. to 18,989,943 kw.-hr.

The effect of power rates on business development is an open question among engineers consulted in this inquiry. There is widespread agreement that forms of rates enabling bills to be easily computed are helpful in dealing with prospective customers and with established customers in industry who like to analyze their power problems. But in the long run it seems that the periodic cost of service over all is the telling factor. Power rates are competitive in essence, and in many cases special contract forms and make-ups are required to enable the central station to meet the situation, though there is a healthy tendency for even large power business to be taken on demand rates of the block type, with low energy charges. On account of the rapid development of interconnection in the territory occupied by the four companies and the practice in some cases of including energy sales to tied-in companies in the power business, it has not been expedient to plot power data in the present study. These sales, where involved in interconnection, fluctuate so widely according to changing load conditions and the availability of hydro power that unit data would be of little significance unless analyzed at more length than can now be accorded. It may be noted, however, that the power sales in kilowatt-hours increased locally in company B from 1921 to 1925 from 64,908,135 to 108,864,667; in company C from 12,129,169 to 41,797,482, and in D from 27,873,752 to 51,479,591. In all these cities, including A, the motor load is well established and isolated plant competition is of little consequence. The industrial electric heating load is being developed,

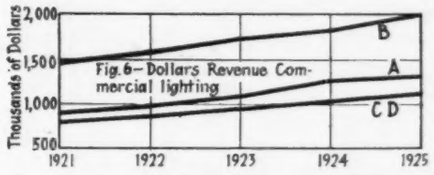
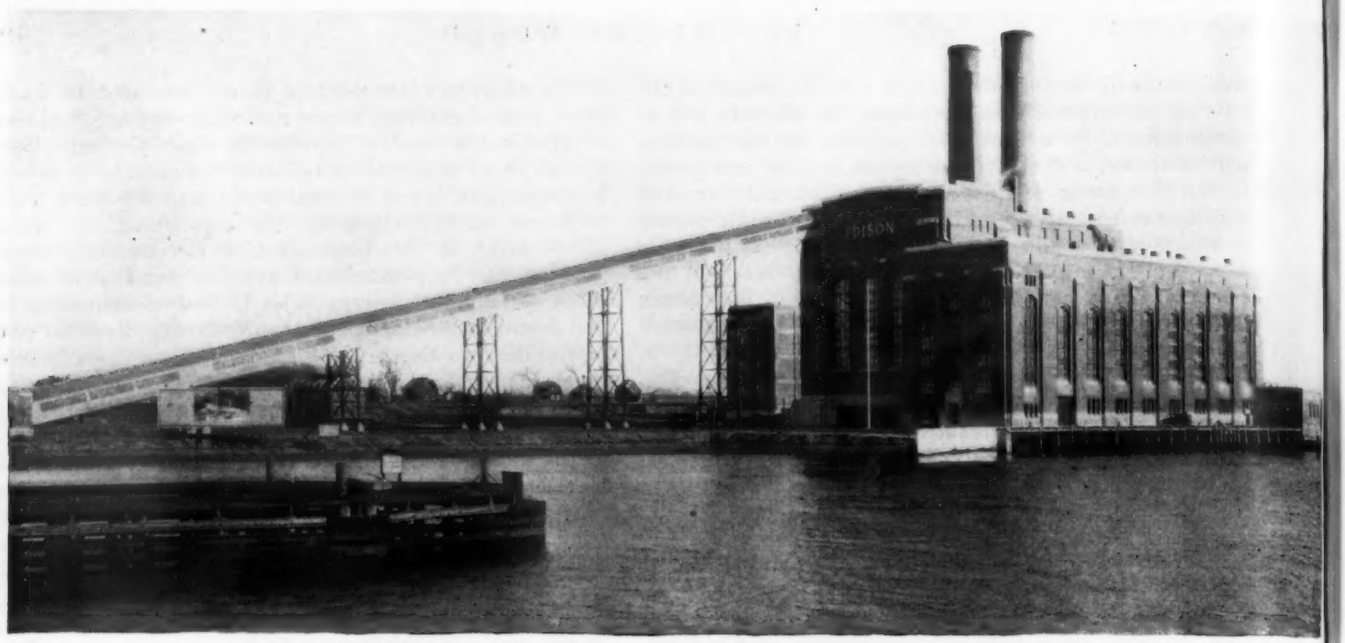


FIG. 6—REVENUE IN DOLLARS FROM COMMERCIAL LIGHTING

and in a few years its influence upon power factor and investment will be considerable. It has proved to be a very fertile field for commercial activity.

Table VIII gives the per capita revenue of each company from total electrical energy sales in the five years. Table IX shows the total revenue, sales and population served in five years. It must be admitted that interconnection affects this, but as all the companies are interconnected with others in a regional network that extends among the four, even if by roundabout routes, the table may be allowed to go in. A healthy per capita gain is apparent over the five years, and it is a good sign that the executives and engineers of the companies studied are thoroughly interested in the rate problem and that further steps to encourage greater use of electricity have been taken via the rate route since the five-year period ended. The old straight-line meter rate is losing favor, and for all classes of business efforts are being made to design schedules to encourage the user to larger enjoyment of the service. Business is becoming far better proportioned from the central-station side, and even before the beginning of the period above studied, load factors were improving and in the four companies little criticism could be made of the shape of the load curves on normal weekdays.

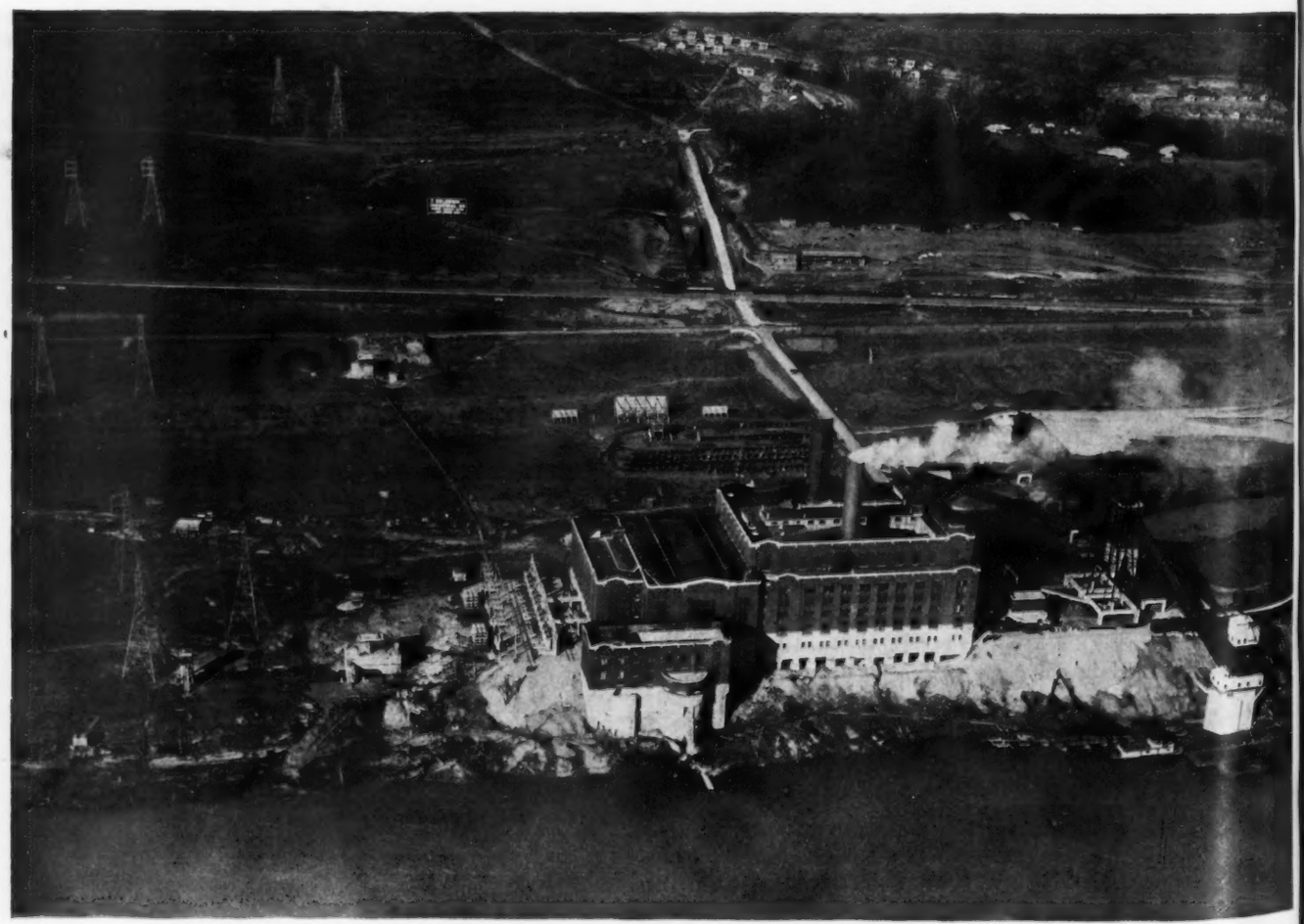
As electric service becomes more nearly universal, it is likely that the number of rate schedules per company may be decreased, but some form of demand and energy charge rate will probably prevail for a long time to come, and the energy component will be low because of its appeal to the customer, its influence on bills as consumption gains, and finally because the cost of production tends to decrease per unit, even while the cost of distribution and of overhead challenges engineering skill to attack all wastes between the busbar and the consumer.



Edgar Station of the Edison Electric Illuminating Company

An Ample Water Supply Is a Necessity for Steam Stations

Columbia Station of the Columbia Power Company



Building a Metropolitan System

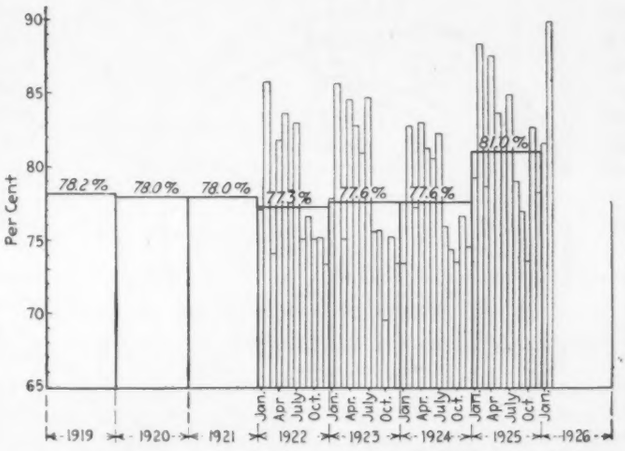
Fundamental Plan of Brooklyn Edison Company System Outlined—Service Continuity at Minimum Cost the Primary Consideration—Ability to Expand Service with Minimum Changes—A Tightly Linked Principle Established

An Interview with
JOHN C. PARKER
Vice-President in Charge of Engineering

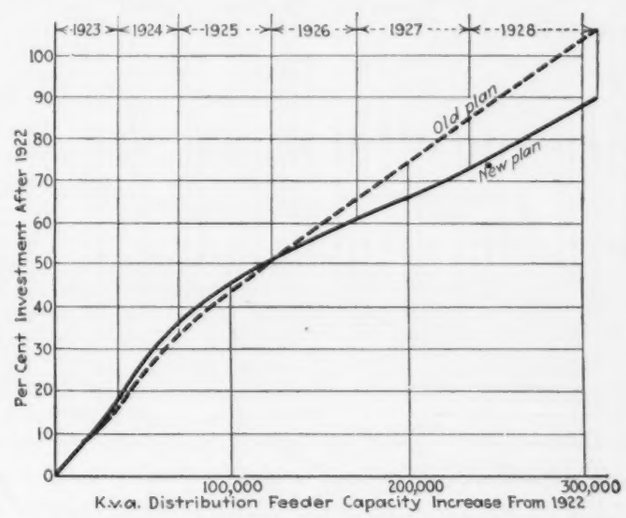
THE Brooklyn Edison Company recently determined upon a fundamental plan for system development and has rebuilt its property to conform to this plan. This utility supplies service to more than 600,000 customers in Brooklyn, which is very largely a residential city with a downtown heavy load density area and an outlying belt of residential suburbs.

Careful studies were made of the system previous to the building of the Hudson Avenue generating station, and the accepted plans for development were based on a detailed study of all present and future service requirements. Since few properties have had the opportunity to build anew, many features of the present system are unique and can be studied profitably by other utility representatives. John C. Parker, vice-president in charge of engineering of the Brooklyn Edison Company, outlined to a representative of the ELECTRICAL WORLD the fundamental features of the system and told of the analyses made before building the present installation.

"Service continuity to customers at the least cost was the first consideration in planning the Brooklyn Edison Company system," stated Mr. Parker. "Further, it was desired to obtain this result by building the simplest possible system and one that could be expanded or changed with minimum trouble and costs. Our studies to secure continuity of service led us to base our plans on the reliability of energy supply to the substations and the feeders through a diversification of the risk to service interruptions. All parts of the system, even to the generating station bus and switching arrangements, were considered in the decision to maintain uninterrupted service on the substations and feeders.



ANNUAL EFFICIENCIES OF BROOKLYN EDISON SYSTEM—NET KILOWATT-HOURS GENERATED VERSUS KILOWATT-HOURS SOLD TO ALL CUSTOMERS



TRANSMISSION, SUBSTATION AND PRIMARY DISTRIBUTION COSTS

Old plan: 13,000-volt, three-phase; 2,400-volt, two-phase.
New plan: 27,000-volt, three-phase; 4,150-volt, three-phase.

"This plan required that each feeder group in any substation, and again each substation on the system, should be directly and independently supplied from an independent generating unit in so far as this was economically possible. It led to the conclusion that generating units should primarily be paralleled at the substations through the use of a large number of flexible tie lines. And it required that the substations be looped on a ring feeder bus consisting of a series of short links and, in addition, extensive use of reactors to limit energy concentrations to faults. In principle neither contiguous substations nor contiguous groups within any substation are served by any two contiguous generators in any one generating station. And tie lines from generating stations to substations are working lines. This avoids surplus investment to secure service reliability or the ability to parallel generating units.

"The use of reactors conforms to the principle of diversity of risk of service interruptions and at the same time makes it possible to secure investment economies in oil switches. The reactors help maintain voltage and service on each feeder by limiting disturbances to their own neighborhood and, further, limit energy concentrations to a predetermined value and thus enable us to install oil breakers which are required to interrupt only limited short circuit values. Yet the use of the Stott system with its synchronizing bus and the use of the multiple tie line principle give a normal reactance drop on the system that is comparatively low because the reactances in series with each feeder are in parallel with respect to the generator and the transmission system and are placed where normal conditions require no current flow."

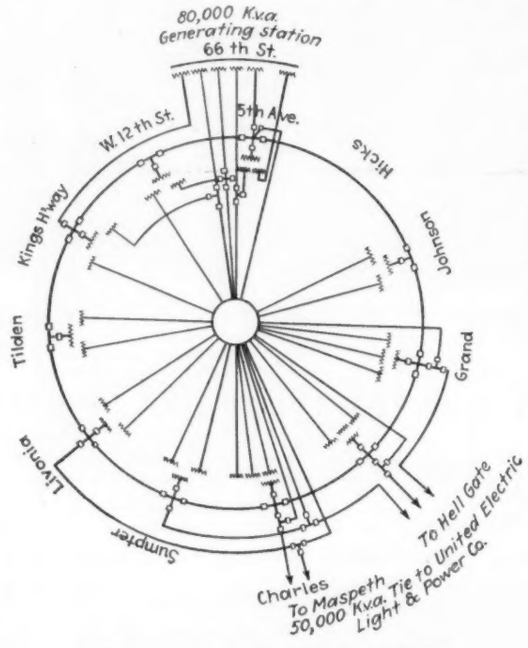
The transmission system of the Brooklyn Edison Company operates at 27,600 volts and 60 cycles. The substations are designed for an operating capacity of from 30,000 to 40,000 kva. and are supplied through 10,000-kva. oil-insulated self-cooled transformers, one spare transformer being installed at each substation. The transformers that carry the load normally are directly connected without high-tension switches to three-conductor, 350,000-circ.mil feeders supplied from the generating stations at transmission voltage. The spare transformer in the substation is supplied through switches from a 27,600-volt ring feeder bus of the same size cable, which loops from substation to substation to form a complete ring. This ring is at present supplied by feeders from the generating stations and connected for interchange with other utilities at some of the substations.

The Hudson Avenue generating station now consists of five sections and will contain ultimately eight or more sections. Each section consists of a north and south group bus, which supplies four transmission feeders so arranged that the ultimate supply to each substation will be from three or four sections. The generators are connected between the ends of adjacent sections so that either of the two or both sections (one, two, three or four groups) may be connected to one generator. Paralleling facilities of high reactance are provided by using a 27,600-volt synchronizing bus to supplement the intersubstation ring tie. Each section of the main bus consists of twelve switches, eight feeder switches and four generator selector switches. In addition to these switches each generator has a main switch and a 10 per cent reactor and switch connection to the synchronizing bus.

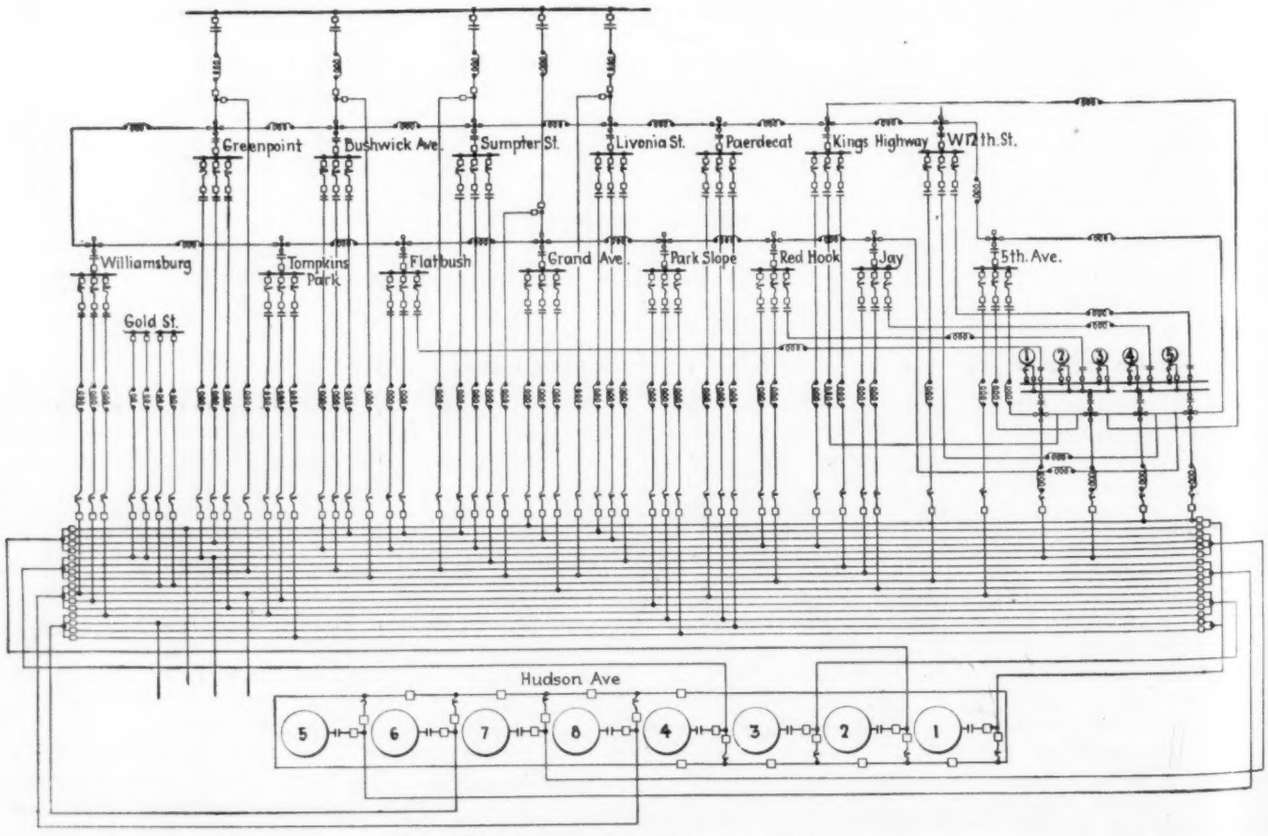
Feeder reactors with feeder switches provide the first barrier to service interruptions by limiting the short circuit to 350,000 kva. These are backed by group switches and synchronizing reactors arranged on the Stott principle as a second line of defense, and in addition there is a third line of defense provided by the switches between the double groups and the synchronizing bus.

The 4,156-volt bus at the substation is separated into three or four sections operated in parallel through 10 per cent reactors in the same manner as in the generating stations and the high-tension side of the substations. All distribution feeders are equipped with 3 per cent reactors.

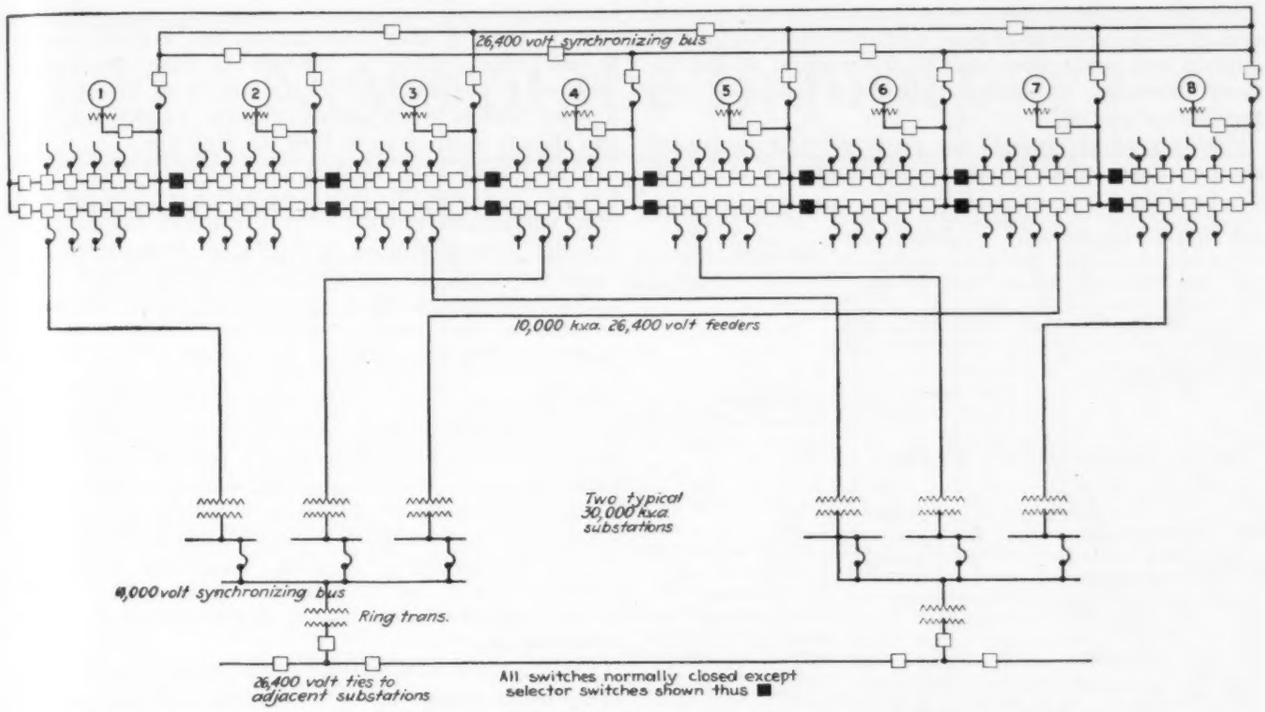
"What principles did you apply to determine upon the size and location of generating and substations?" was the next question asked Mr. Parker after



THE TRANSMISSION SYSTEM IN 1925



THE TRANSMISSION SYSTEM IN 1930



ONE-LINE DIAGRAM OF THE HUDSON AVENUE 27,000-VOLT BUS AND SUPPLY CONNECTIONS TO TWO SUBSTATIONS

he had outlined the system to the interviewer as related in the foregoing and had shown the connections given by the accompanying graphs.

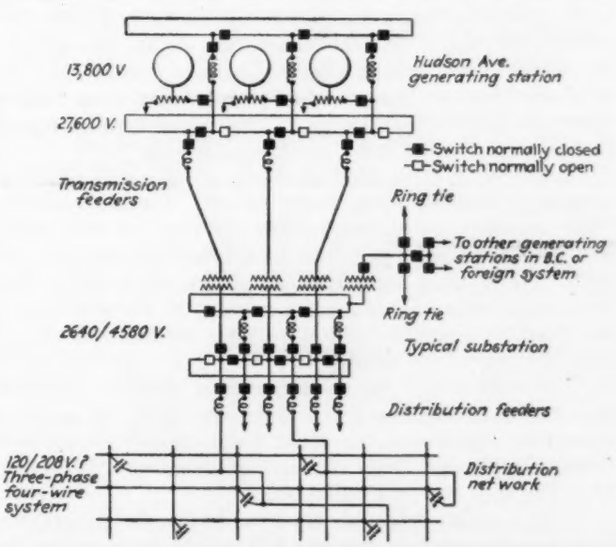
"The location of a power station is pretty well fixed by reason of permissible sites," he replied. "Water supply, fuel supply and the ability to get the generated energy out into the system are governing factors, but the price of real estate and the economic load center are influential considerations. The rating of a generating station is made on a rule-of-thumb basis, but our experiences convince us that eight or ten generating units of the largest rating that can be purchased make a very satisfactory station for a community like Brooklyn.

"The substation location should be determined by applying the rule that it should be placed at the economic center of the prospective load, and the rating of a substation is fixed by securing a balance between distribution economies on the one hand and substation investment and operating economies on the other. A large number of small substations gives the highest distribution economies, but the fewest number of large substations makes for decreased substation operating and investment costs. Our experience and analyses lead us to believe that a substation capacity of between 30,000 and 60,000 kva. is the best and most economical to install for our load densities."

"What determined the number and voltage of your transmission and distribution systems?" was next asked Mr. Parker. He answered quickly: "We believe that a minimum number of transmission and distribution voltage systems should be used, and our studies showed us that the use of a 27,600-volt transmission system and a 4,156-volt grounded, four-wire, three-phase distribution system cares for present conditions on our system most economically and will provide for future requirements for an indefinite number of years. But should it be found desirable, the transmission voltage can be changed or the distribution system voltage can be changed without disturbing the system in the least. These changes could be made without changing any principle of the system plan and with a minimum additional investment cost and operating trouble.

"We believe that transmission feeders should be used only for transmission purposes. But if any large customers are available, they can be treated as substations and served by direct transmission feeders without difficulty. Each transmission feeder, including its transformer, is a unit without any intervening system. With a reasonable load density we are able to use a standard size of distribution feeder up to the transformer and a series of single-conductor ring mains from there on, so that it is economical and easy to add a new substation to the system by simply cutting into the main or the feeder and making connections.

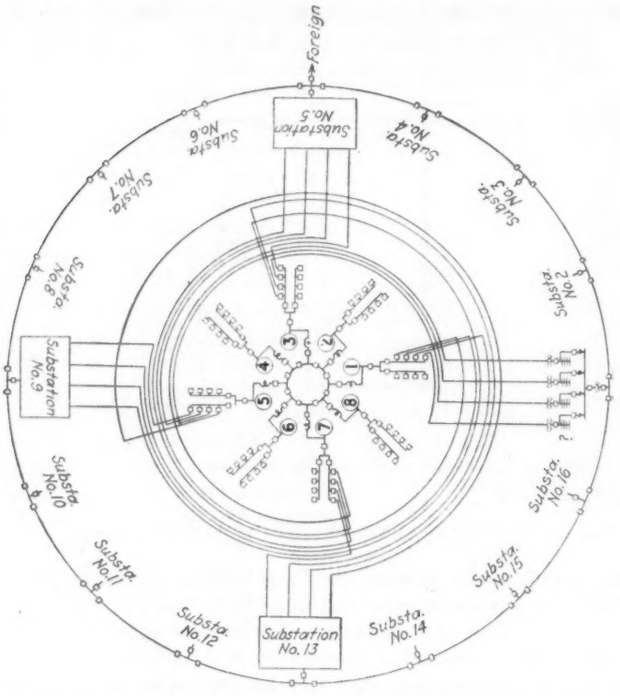
"Thus if the distribution primary mains cover the whole service territory, they will serve all future needs except for isolated services to very large customers. It is possible to install new substations without any



TYPICAL SUBSTATION WITH SUPPLY TO PROPOSED LOW-VOLTAGE NETWORK FOR THE DOWNTOWN SECTION OF BROOKLYN

change in the transmission or distribution layout except cutting and connecting, and as the number of substations increases, an increasingly short length of new feeder is required."

"Does your system call for an investment in unused equipment in order to secure reliability of service?"



THE FUTURE TRANSMISSION SYSTEM, WHICH ILLUSTRATES THE PRINCIPAL SYSTEM DESIGN COMPLETELY CARRIED OUT

was another query to Mr. Parker. It brought an answer promptly. "The diversification of supply on this system has been obtained by systematic planning and arrangement rather than by a multiplication of supply lines. Not one foot of cable or one switch has been installed in carrying out our plan except the cables and switches that are necessary to give the normal working supply of energy to customers. The only exception is in the case of the tie feeders of the ring between substations. These represent one very short tie from each substation to an adjoining substation and give two sources of supply to each substation in an emergency, as against the one emergency source that would be available through the use of a spare transmission feeder from the generating station. This latter type of spare feeder would be at least five times as long."

"Does the system lend itself to simple and positive relaying?" was another question. Mr. Parker replied: "The system requires a minimum of relaying and gives a high degree of selectivity. At the generating stations inverse time limit overload relays are used; at the substation ends of the feeders simple directional relays are used, and on the substation ring inverse time limit overload relays are needed.

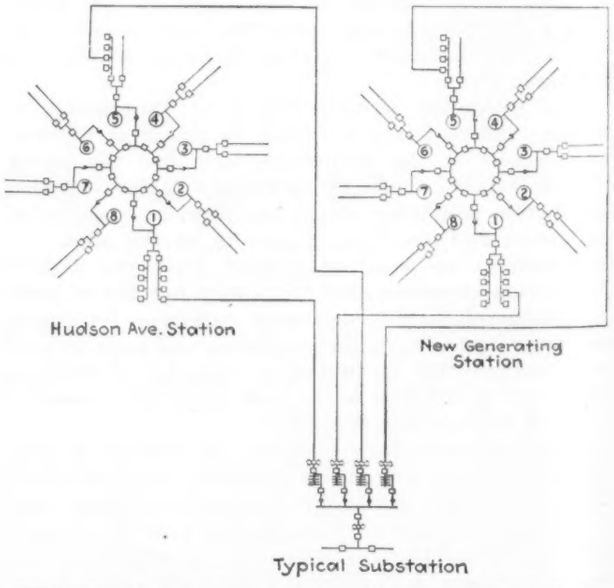
"The reason for the simplicity in relaying is that all circuits except the faulty ones are identical in their operating relation to the fault when trouble arises and there is a heavy concentration of reactance in series with the spot where trouble occurs.

"In the event of trouble that would completely cripple a generating station energy still would be supplied to each substation. The ring bus also permits any one substation to be supplied from adjacent substations even though none of these substations has a direct supply to the ring. This is possible because the energy received at the adjacent substations from direct-transmission feeders is stepped down to the 4,156-volt system and then is stepped up to feed the ring bus.

"The relays have worked splendidly on the system. Out of 34 faults on the transmission system with 49 relay operations, 47 were correct, one was incorrect and one relay operated when it should not have functioned. In no case was any customer's service affected."

"Is your system power factor and voltage regulation affected by your reactor installations?" was a natural question asked Mr. Parker. He replied: "Our reactors normally carry no current, as they are arranged on the Stott principle. The system operates at a high power factor and no induction regulators are required except those necessary to compensate for the effect of normal load changes. Only a 3 per cent reactance is placed in a transmission feeder in addition to the normal generator and transformer reactances of the system, and this reactance pays for itself many times over by permitting us to use commercially cheaper oil breakers, to say nothing of its screening the generator bus from local troubles."

In a general summation of the system advantages Mr. Parker stated: "With a system built on the principles outlined, it would be possible to rebuild any obsolete generating station, to replace any obsolete generating equipment, to build and connect a new station or to make additions to an existing station without making any changes in the system as a whole. For example, units of 50,000-kw. rating were first used in the Hudson Avenue station, but units of 80,000-kw. capacity are now being installed without necessitating any change in the transmission system or principles of connection. It is possible to change from a transmission feeder of 10,000 kw. to one of 20,000 kw. without altering the scheme of connections, and the



SINGLE-LINE CONNECTIONS FOR TWO GENERATING STATIONS TO A TYPICAL SUBSTATION

voltage of the transmission or distribution system also may be changed readily.

"We believe we have a system that is completely flexible, with complete diversification of risk to service and one that gives the best operating simplicity for maintaining continuous service."

News of the Industry

Chances for Muscle Shoals Bill Improve

Advocates Evince Purpose to Pass It at This Session Despite Opposition of Public Ownership Senators and the Fertilizer Interests—Plans of Southern Companies

By PAUL WOOTON
Washington Correspondent ELECTRICAL WORLD

AN INCREASING determination to pass the Muscle Shoals bill at this session of Congress is in evidence in the Senate. When the joint committee first recommended the acceptance of the offer made by the associated Southern power companies many were of the opinion that, in view of the desire for adjournment, the opposition would be sufficiently strong to prevent action.

The principal opposition comes from those senators who believe in public ownership. Despite some intimations to the contrary, it is believed that this group will place every obstacle in the way of the legislation; but if the Muscle Shoals bill is called up immediately after the railroad labor bill, as now is planned, a filibuster against the measure may be discouraged. The Senate by a vote of 39 to 31 tabled a motion by Senator Norris of Nebraska to refer the bill to the committee on agriculture, of which he is chairman.

It is expected that the fertilizer industry will oppose the legislation. The policy of the National Fertilizer Association, however, has not been determined as this is written. The executive committee of that organization has the matter before it and is expected to make an early report. It is understood, however, that the general feeling in the industry is that it is very unfair for the government to require large production from an industry already overdeveloped. On the other hand, the power companies point out that Germany has emancipated Europe from the Chilean nitrate monopoly. That country is producing more than 400,000 tons of nitrogen annually. The representatives of the Muscle Shoals Fertilizer Company fail to see why there should be any apprehension growing out of a production of 40,000 tons of nitrogen which is spread over a long period of years.

Plans of Southern Power Companies

So as to have their plans fully matured in the event that Congress should approve the recommendation of its joint committee for the disposition of the properties, the directors of the Muscle Shoals Fertilizer Company and of the Muscle Shoals Power Distributing Company outlined a program at a meeting held in Washington last week. After the meeting Thomas W. Martin, the president of the Muscle Shoals Power Distributing Company, made this statement:

"The construction program worked out by the experts of the fertilizer company for installing a modern synthetic process for nitrogen fixation and fertilizer production was carefully gone over and approved in order that the construction of the first unit with a capacity for 10,000 tons of fixed nitrogen and necessary phosphoric-acid plants can be begun immediately following approval by Congress. The question of equitable distribution of power in the several states, involving the construction of necessary transmission lines and facilities, was discussed by the directors, several of whom are executive heads of the public utility power companies which will participate in power distribution."

After the meeting Dr. Louis C. Jones, an authority on nitrogen, who is vice-president of the fertilizer company, announced that the company is prepared to begin immediately the designing and construction of plants for the production of concentrated commercial fertilizers. Dr. Jones explained that the Muscle Shoals Fertilizer Company is fortunate in having on its technical staff Dr. R. F. Bacon, who was chief of the chemical section of the allied armies of France on the staff of General Pershing. Dr. Jones has already designed, constructed and put into operation several nitrogen plants in the United States and has made a thorough study of all existing processes in operation both in this country and abroad.

"We propose in the first fertilizer unit to be built at Muscle Shoals," said Dr. Jones, "to use the well-known Haber process as modified for the fixation of nitrogen and an equally well-known sulphuric-acid process for making phosphoric acid, and we will combine these products in a concentrated commercial fertilizer as ammonium phosphate, which will contain approximately 15 per cent nitrogen and 60 per cent phosphoric acid, two principal plant foods required for soil fertilization.

"The use of these processes in the production of fertilizer has been held back in this country because of a lack of capital. The Muscle Shoals Fertilizer Company is not handicapped in this respect since it is provided immediately with ample capital through its connection with the Muscle Shoals Power Distributing Company. Under the terms of the proposal the fertilizer company is required to have in operation the first unit within three years, but our intention and expectation is that we shall be actually delivering fertilizer to farmers within a much shorter period, perhaps not more than half that time.

"There is no element of doubt in our minds of our ability to carry out, without difficulty, the obligations of the fertilizer proposal, and we do not hesitate to assure the farmers and the public that the project we propose to enter upon will result for the first time in a substantial reduction in the cost of plant food and improvements in the quality of fertilizer needed by the American farmer."

Ransdell and Harrison for Bill

Discussing the associated power companies' bid, Senator Ransdell of Louisiana said: "If Congress is to escape more criticism for inability to reach a conclusion on any business question, it seems to me that this bid should be voted up or voted down promptly. We have been considering Muscle Shoals for several years. I think the bill should be disposed of at this session. It is very gratifying to me that we have escaped from the Ford idea of getting up a great industrial center at Muscle Shoals. The fight now resolves itself into a contest between those who favor public ownership and operation and those who favor the conduct of business by private enterprise. I am unalterably opposed to the government's embarking in business enterprises that compete with its citizens."

A renaissance of industry in Mississippi and Lousiana is foreseen by Senator Harrison of the former state if Congress will approve the offer of the associated Southern power companies for the government's Muscle Shoals properties. "It seems to me," the Mississippi Senator said in the course of a formal statement, "that every safeguard is provided to guarantee to the government reimbursement for its large expenditures at Muscle Shoals and to insure cheap fertilizer and cheap power."

Another Public Ownership Campaign in California

A third attempt is to be made in California to put over the water and power act which was defeated at the polls in 1922 and again in 1924. An initiated measure providing for submitting the power bill again in November next is now in the hands of the Attorney General for titling, and petitions for its submission will soon be circulated. This bill, it is learned, is identical with the one twice defeated.

The law, if enacted, would give a board of five authority to spend the proceeds of a bond issue of $500,000,000 to put the state into the power business. It is said that Rudolph Spreckels will again finance the campaign. There is some talk of tying the gubernatorial race of Lieutenant-Governor C. C. Young up with the water and power act. In 1922 the bill was defeated by a ratio of 2.45 to 1 and in 1924 by a ratio of 2.35 to 1.

Secretary Mellon and William Green to Address N.E.L.A.

In addition to William Allen White, Owen D. Young, Secretary of Labor Davis, Guy E. Tripp, A. G. Patterson and the other speakers from outside the working ranks of the light and power companies listed last week, the National Electric Light Association has the promise of addresses from Andrew W. Mellon, the Secretary of the Treasury, and William Green, president of the American Federation of Labor. Mr. Mellon will address the session of the public policy committee on Wednesday evening, May 19, of which the proceedings will be broadcast. Mr. Green, who will take as his subject "Electricity in Industry," will speak at the sixth general session on Friday morning, May 21. The full tentative program of the convention is printed below.

N. E. L. A. 1926 Convention Program

ATLANTIC CITY, MAY 17-21

(Subject to Augmentation or Slight Change)

General Sessions

TUESDAY, MAY 18, 9:30 A.M.

Address of welcome, Mayor E. L. Bader.
Address, President James E. Davidson.
Report of treasurer, W. A. Jones.
Report of managing director, M. H. Aylesworth.
Report, M. S. Sloan, chairman Public Relations National Section.
Address, Owen D. Young (subject to be determined).
Address, "What Is the Function of the N. E. L. A.?" R. H. Ballard.
Report of committee on constitution and bylaws, W. C. L. Eglin.

WEDNESDAY, MAY 19, 9:30 A.M.

Address, "Insurance in the Electrical Field," G. H. Bourne.
Report, E. W. Lloyd, chairman Commercial National Section.
Address, Edwin Gruhl, North American Company (subject to be determined).
Address, Samuel Insull (subject to be determined).
Address, "Better Industrial Lighting," Secretary of Labor James J. Davis.
Report of industrial lighting committee, Joseph F. Becker.
Award of prizes in Industrial Lighting Activity.
Address, "Budgeting Business," A. C. Marshall.

WEDNESDAY, MAY 19, 2:30 P.M.

Address, "Public Relations," B. C. Forbes.
Award of prizes in Forbes public relations contest.
Address, "Railroad Electrification," John W. Lieb.
Address, "Domestic Cooking and Heating," Franklin T. Griffith.
Dialog, "Satisfying the Customer," Mrs. Ruth P. Steinhauser of Shreveport, La., and Miss Vanable Seale of Beaumont, Tex.
Address, "Social and Economic Aspects of Interconnected Systems," W. E. Creed.
Address, "Opportunities Measured by Responsibilities in Radio," David Sarnoff.
Addresses, "Electrification of Agriculture," G. C. Neff and Frank Evans, counsel American Farm Bureau Federation.

THURSDAY, MAY 20, 9:30 A.M.

Address, "Lowering Wiring Costs," A. P. Good.
Announcement of awards in N. E. L. A. contests, W. H. Onken, Jr.
Address, William Allen White, editor Emporia (Kan.) *Gazette* (subject to be determined).
Address, "Growth of the Electric Light and Power Industry Under Regulation," A. G. Patterson, president National Association of Railroad and Utilities Commissioners.
Address, Bruce Barton (subject to be determined).
Address, "Electrifying the American Home," Mrs. Mary King Sherman, president General Federation of Women's Clubs.
Discussion of inductive co-ordination by R. F. Pack and Bancroft Gherardi.

THURSDAY, MAY 20, 2:30 P.M.

Report of committee on N. E. L. A. educational courses, Fred R. Jenkins.
Address, "Interchange of Energy," E. J. Fowler.
Address, "Superpower as an Aid to the Decentralization or Distribution of Industries," Guy E. Tripp.
Report, C. F. Hirshfeld, chairman Technical National Section.
Address, "A Thesis and a Question," Alex Dow.
Address, "Sales Organization and Management," S. D. Heed. (Discussion by Henry L. Doherty, Samuel Insull, Sidney Z. Mitchell and Owen D. Young.)

FRIDAY, MAY 21, 9:30 A.M.

Memorial address, W. H. Onken, Jr.
Address, "Commercial Possibilities of Home Lighting," M. Luckiesh.
Report, C. M. Breitinger, chairman Accounting National Section.
Address, "Electricity in Industry," William Green, president American Federation of Labor.
Address, "Electric Refrigeration," G. E. Miller.
Address, "Merchandising," T. L. Phillips.
Report of resolutions committee, W. W. Freeman.
Report of nominating committee.
Election of officers.

Public Policy Committee Session

WEDNESDAY, MAY 19, 8:30 P.M.

Report of public policy committee, M. J. Insull.
Report of Charles A. Coffin prize committee.
Award of Coffin medal.
Address, Secretary of the Treasury Mellon.
(Program interspersed with music by Vincent Lopez orchestra and Elizabeth Rethberg, soprano.)

Public Relations Session

TUESDAY, MAY 18, 2:30 P.M.

Report of Chairman M. S. Sloan.
Committee Reports:
- Co-operation with educational institutions, John C. Parker.
- Customer ownership, A. Emory Wishon.
- Women's, Elizabeth Lee.
- Industrial relations, Homer E. Niesz.
- Information Bureau organization, H. C. Abell.
- Manufacturers' advertising, J. C. McQuiston.
- Public relations advertising and information, W. H. Hodge.
- Public speaking, W. S. Vivian.
- Relations with financial institutions, M. S. Sloan.

Technical Session

TUESDAY, MAY 18, 2:30 P.M.

Report of Chairman C. F. Hirshfeld
Committee Reports:
- Accident prevention, Charles B. Scott.
- Electrical apparatus, E. C. Stone.
- Hydraulic power, R. L. Thomas.
- Inductive co-ordination, Howard S. Phelps.
- Meter, A. G. Turnbull.
- Overhead systems, H. C. Sutton.
- Prime movers, A. D. Bailey.
- Underground systems, C. H. Shaw.

Address, "Cause and Prevention of Embrittlement in Boilerplate," Prof. S. W. Parr, University of Illinois.
Address, "Significance of Codes and Standards," John C. Parker.

Commercial Session

TUESDAY, MAY 18, 2:30 P.M.

Report of Chairman E. W. Lloyd.
Committee Reports:
- Power, V. M. F. Tallman. Subcommittees: Commercial cooking, A. M. Lloyd; competitive power, H. W. Derry; industrial heating, W. H. Sammis.
- Load factor, R. H. Tillman.
- Transportation, B. J. Martin.
- Customer ownership, Roy T. Duncan.

Accounting Session

TUESDAY, MAY 18, 2:30 P.M.

Report of Chairman C. M. Breitinger
Addresses by national committee chairmen.
Addresses:
- "Federal Taxation," R. H. Montgomery, of Lybrand, Ross Brothers & Montgomery, New York.
- "Fixed Capital," C. W. Kellogg, president Engineers' Public Service Company, New York.
- "The Banker's Viewpoint on Electric Utilities," R. E. Norton of W. H. Newbold Sons & Company, Philadelphia.
- "Holding Companies," T. J. Grayson, University of Pennsylvania.
- "The Electrical Utilities' Legal Problems," R. J. Baker, of Hause, Evans & Baker, Harrisburg, Pa.
- "Retirement Accounting Versus Depreciation," L. R. Nash, vice-president Stone & Webster.

Practical Talks at Lincoln

Nebraska Section, N.E.L.A., Occupied in Discussion of Commercial and Customer Topics

COMMERCIAL topics easily occupied the forefront of the Nebraska Section convention at Lincoln on April 29 and 30. Radio interference, rural service, addresses by commissioners on human relations and utility regulation, employee relations, accident prevention and women's activities in the industry were other subjects of discussion. About one hundred persons were registered and nearly 250 attended the banquet, women of the industry being very well represented.

The commercial session, presided over by Chairman C. D. SeCheverell, was opened by an excellent presentation, entitled "Back to Business," by H. E. Young, and then devoted to discussions on various commercial subjects. Mr. Young said that, while the profitableness of the electric range load and the servicing cost of domestic refrigerators apparently stand out as two fundamental question marks in some companies' minds, he had great confidence in both loads as business builders.

A case for the domestic refrigerator was made out with enthusiasm by R. E. Fee; some fundamentals of sales work were outlined by C. A. Nash, and establishment of customers' credits and methods of collection were considered by Stanley Taber.

H. K. Baylor pointed out that electrification of industry to 3½ hp. per wage earner has been chiefly responsible for greatly increased productivity and high wages and that further electrification of the home, which now produces 25 per cent of the revenue, can easily double the present 14 per cent load factor and thus double the utilization of the service investment.

A representative of the Lincoln Radio Listeners' League commended the cooperation of the light and power companies in removing causes of interference with reception and suggested listeners' leagues as the go-between. The methods used in Kansas in "running down" radio interference complaints and removing their causes were explained by O. H. Byers and F. J. Gunther.

Rural service activities in Nebraska were outlined by W. R. McGeachin; Dean Ferguson discussed trial-and-error methods of investigation; ex-Governor McKelvie emphasized factors affecting agricultural prosperity; Prof. E. E. Brackett went into some details of the work of the Nebraska Committee on the Relation of Electricity to Agriculture, and Commissioner Taylor expressed the belief that farm electrification must be based on economy.

O. J. Shaw, chairman public relations committee, declared that "good spirit" was as essential as good service. Commissioner L. C. Oberlies illustrated parallels of utility human relations problems in state institutions. N. W. Simpson, former utility commissioner in Missouri, contended that no group of customers, such as farmers, should be served at the expense of another group.

Under the chairmanship of Bernice Runyon, Ruth Menoher and Lorrayne Schacht presented papers on women's activities, which were also discussed by other women and executives. K. Goewy described a three-day sales camp at Grand Island, and the benefits of a regional lighting sales school at St. Joseph, Mo., were recounted by J. W. Read.

C. D. SeCheverell, vice-president Central Power Company, Grand Island, was elected president of the section for the coming year; O. J. Shaw, general manager Lincoln Traction Company, vice-president, and Horace M. Davis was re-elected secretary-treasurer.

Rural Service the Keynote

Missouri Public Utilities Association Hears Encouraging Reports of Progress Made

ELECTRIFICATION of farms was the principal subject of technical interest to the electrical industry at the twentieth annual convention of the Missouri Association of Public Utilities held at the Shrine Mosque, Springfield, Mo., May 3 to 5. F. S. Dewey, of the Kansas City Power & Light Company, chairman of the utilities section of the proposed Missouri Committee on the Relation of Electricity to Agriculture, reported that organization plans had been perfected and that adequate financial support was in sight.

About 4,000 rural customers are being served by transmission lines, Mr. Dewey said, but there are 256,000 farms in Missouri. Rural electrification has been proceeding rapidly in the northern part of the state, where the St. Joseph Transmission Company of Oregon, the Kansas City Power & Light Company, the Trenton Gas & Electric Company and the Missouri Power & Light Company are active. Electrification of farms is also making gains in the southeastern and southwestern sections, where the Empire District Electric Company and the Missouri Utilities Company have made effective efforts to extend the work.

The principal address of the convention was that of L. E. Gettle, chairman of the Wisconsin Railroad Commission, upon the "Operation of the Indeterminate Permit in Wisconsin." Mr. Gettle spoke with force and enthusiasm and had an attentive audience. He said that Wisconsin believed it to be impossible to accomplish effective regulation unless it was based on the indeterminate permit.

The report of Mary McKelvey, chairman of a committee on women's information, attracted much attention. The association offered two prizes (of expenses to the Atlantic City convention) for the best essays on "Why Public Utilities Need the Assistance of Women." These prizes were won by Maude Bryan of the Laclede Gas Light Company of St. Louis and Bernadette Hock of the Missouri Utilities Company of Cape Girardeau, who read their papers before the convention.

Officers for 1926 will be: President, F. S. Dewey, vice-president Kansas City Power & Light Company; first vice-president, W. H. Henby; second vice-president, O. W. Mattison; third vice-president, A. E. Reynolds; secretary-treasurer (re-elected), F. D. Beardslee.

Purchases and Mergers

New York State Figures Prominently in This Week's Crop—Foshay Buys California Properties

PERMISSION has been granted by the New York Public Service Commission for the purchase by the Plattsburg Gas & Electric Company of the franchises, works and systems of the Chasm Power Company of Chateaugay, the Champlain Electric Company of Champlain and the plant of Norman I. White of Ellenburg. These three systems serve a wide territory in Franklin and Clinton Counties and it is proposed to link them with the Plattsburg plant. The commission fixed the valuations at which the properties are to be transferred as follows: Chasm Power Company, $162,511; Champlain Electric Company, $80,067; Norman I. White, $18,623.

The New York Public Service Commission has also approved the previously reported consolidation of the Rockland Light & Power Company, the Orange County Public Service Company and the Catskill Power Corporation into the Rockland Light & Power Company. All the franchises, works and systems of the three concerns will go into the new corporation, which is authorized to issue $5,150,000 of common stock and $100,000 of preferred.

The Halfmoon Light, Heat & Power Company of Mechanicville, N. Y., and the Salem (N. Y.) Light, Heat & Power Company desire to transfer their franchises, works and systems to the Eastern New York Electric & Gas Company of Granville. The stock of all three companies is owned by the Associated Gas & Electric Company, and it is desired to merge them into one operating unit.

The Public Service Commission of New York has authorized William V. Ottman to transfer the franchises, works and system of an electric plant in portions of the towns of Verona and Vienna, Oneida County, N. Y., to the Niagara, Lockport & Ontario Power Company for the sum of $21,000.

The American Utilities Company, a holding company with offices at Harrisburg, Pa., has been authorized by the Missouri Public Service Commission to acquire the capital stock of the Missouri General Utilities Company, which had recently purchased electric light and waterworks plants in Ste. Genevieve, St. Mary's, Bloomfield and Perryville, Mo., for approximately $400,000.

Purchase of the electric utility properties of the Wisconsin Hydro-Electric Company of Amery, Wis., and the electric properties of the Municipal Corporation, which serve forty small communities in Wisconsin, has, news reports say, been effected by the W. B. Foshay Company. The company is also reported to have bought electric properties in Alturas & Mendocino, Cal., and the Viborg (S. D.) Electric Service Company. These new properties, as well as others recently acquired by the Foshay interests, will be controlled by the People's Light & Power Corporation.

Sale by the Electric Construction Company of Grand Forks, N. D., to the Red River Power Company of Grand Forks of electric properties at Buxton,

Reynolds and Thompson has been approved by the North Dakota Railroad Commission.

The Great Western Power Company of California has made application to the Railroad Commission to purchase all of the outstanding common stock of the Napa Valley Electric Company, a small utility supplying electric service to the towns of St. Helena, Oak Knoll and Rutherford and surrounding territory in the Napa Valley, north of the San Francisco Bay region. The system of the Great Western Power Company is connected with the Napa company at a point about 10 miles north of the town of Napa.

New Company Takes Control of Indianapolis Light & Heat

Announcement comes from Indianapolis of the incorporation in Delaware of the Indianapolis Power & Light Corporation to take over approximately 71.5 per cent of Indianapolis Light & Heat Company common stock, representing all the common stock of that company not owned by the Insull interests. Walter C. Marmon will continue as president of the Indianapolis Light & Heat Company and will also be president of the new company, the Indianapolis Light & Heat continuing under the same management that has directed its operations for many years.

The Utilities Power & Light Company of Chicago, of which Harley L. Clarke is president, took the lead in the plan and will manage the company. This company sold the Indiana Power Company to the Insull interests last year. Announcement that the latter interests, through the Middle West Utilities Company, had acquired 28½ per cent of the common stock of the Indianapolis Light & Heat Company was made in March of this year, and it was then rumored that the purchasers' intention was to gain control of the Light & Heat company and merge it with the Insull-owned Merchants' Heat & Light Company, thus bringing about unified service in Indianapolis.

Tour of International Delegates Ended

Canada Extends a Hearty Welcome—Entertainment at Boston and Schenectady—Public Men and College Heads Join the Industry in Paying Them Honor

AFTER visiting Philadelphia, Washington, Pittsburgh, Chicago, Detroit and Niagara, as recounted in last week's issue, the touring delegates to the meetings of the International Electrotechnical Commission in New York spent two days in Canada, where John Murphy, of the Department of Railways and Canals, took charge of the party, aided by local committees. After an inspection of the Queenston power plant on Friday, April 30, the Hydro-Electric Power Commission of Ontario entertained the visitors at dinner at the Foxhead Inn, on the Canadian side of the Falls, Chief Engineer F. A. Gaby of the commission acting as toastmaster.

A brief stay in Toronto Friday afternoon and evening, when Chief Justice Mulock welcomed the delegates at the University of Toronto, of which he is chancellor, was followed by Saturday in Ottawa and Sunday in Montreal. At the Canadian capital the delegates were welcomed by Rodolphe Lemieux, Speaker of the Dominion House of Commons, in English and French. They afterward viewed some of the power plants of the International Paper Company on the Ottawa River. Speeches had previously been made during breakfast at the Chateau Laurier by Mayor Balharrie, Minister of Railways Dunning, President Semenza and Clayton H. Sharp. A bronze bust of Minerva was presented by the International Commission to the Canadian National Committee, for which Dr. Howard T. Barnes, of McGill University, the chairman, expressed thanks.

Montreal was reached at 7 p.m. and a hearty welcome extended by the local hosts, with a dinner-dance at the Windsor Hotel. A 60-mile drive around the island and luncheon at the Ritz-Carlton, where Dr. Arthur Surveyer, past-president of the Engineering Institute of Canada, spoke, varied the well-earned Sunday rest.

The members of the commission and accompanying guests received a royal welcome at Boston on Monday from the leading electrical and educational interests centering in the Hub. Upon arrival by special train from Montreal at 10:15 a.m., the party was greeted by President Charles L. Edgar of the Edison Electric Illuminating Company of Boston, chairman of the committee on arrangements, and a group of distinguished associates. Motor trips were immediately under way to points of engineering and scientific interest, including, for the ladies, a trip to Wellesley College and luncheon at the Tedesco Country Club in Swampscott. The men of the party were shown the 1,200-lb. steam boiler and turbine installation in operation in the new Edgar station at Weymouth, and a number visited the research laboratory of Dr. Elihu Thomson at the General Electric Company's Lynn works. Luncheon was served at the residence of President S. W. Stratton of the Masschusetts Institute of Technology, and in the afternoon inspection of the institute, of the new high-voltage laboratory of the Simplex Wire & Cable Company and of the engineering laboratories and museums of Harvard University aroused much interest. President Lowell of Harvard and Mrs. Lowell received the party in the faculty room, after which tea was served.

The visitors were the guests of the committee for dinner at the Country Club, Brookline, at which informal farewell addresses were given by President Semenza and various delegation heads, followed by motion pictures of engineering and popular interest.

The party left Boston at midnight for Schenectady, where, under the chaperonage of the General Electric Company, Tuesday was spent in visiting that company's plants and laboratories, Dr. E. W. Rice, Jr., serving as chairman of the committee in charge. At the research laboratories a talk on various technical subjects was made by Dr. W. R. Whitney. On Wednesday morning the party proceeded to Albany by trolley and Poughkeepsie by rail, thence taking the Hudson River steamboat *Alexander Hamilton* for New York, the end of the trip.

DELEGATES TO INTERNATIONAL ELECTROTECHNICAL COMMISSION MEETING GREETED AT WASHINGTON BY PRESIDENT COOLIDGE

One of the most pleasant features of the our of part of the eastern United States and Canada taken by the foreign delegates o the recent meetings of the International Electrotechnical Commission in New York was their visit to the White House, where President Coolidge extended a welcome. Standing on the President's left in the photograph are Signor Semenza of Italy, the head of the International Electrotechnical Commission, and Dr. C. O. Mailloux, honorary president from the United States.

Ottawa Talks Water Power

Public Control of All Sites Advocated and Condemned—Notes on Power Projects—Chicago Assailed

IN THE Canadian House of Commons a week or two ago there was a lively debate on the question of public versus private ownership of water powers. One member declared that utilization of all water power in Canada should be placed under one centralized board which would operate and develop it for the general advantage of the Dominion. He deplored the practice of giving thirty-year leases. C. H. Cahan, a member for Montreal, said, on the other hand, that he was prepared to vindicate the proposition that the private hydro-electric enterprises of Quebec served the public as cheaply and successfully as the Hydro-Electric Power Commission of Ontario. He contended that Quebec should be allowed to proceed along the lines of its own ideals, which were those of private enterprise and initiative, and argued that it would be as logical to suggest that the government take over the wheat fields of the West as to propose that it spend a hundred millions on acquiring water powers. He pointed out that the Montreal Light, Heat & Power Company paid $650,000 in federal income tax, while the Hydro-Electric Power Commission of Ontario contributed nothing.

GATINEAU, OTTAWA, SAGUENAY

There is a possible development of 600,000 hp. on the Gatineau River properties in the Province of Quebec controlled by the International Paper Company, according to A. H. White of New York, chief engineer of the company, who recently addressed the Ottawa branch of the Engineering Institute of Canada. The total cost of the storage dam above Maniwaki, the electrical development and the paper mill to be erected at East Templeton will be in the neighborhood of $50,000,000, he said. Mr. White confirmed the purchase of Paugan Falls from the Hull Electric Company and said that plans and surveys had been made for its development. The power plants at Paugan Falls, Chelsea and Farmers Rapids will deliver 405,000 hp., he said.

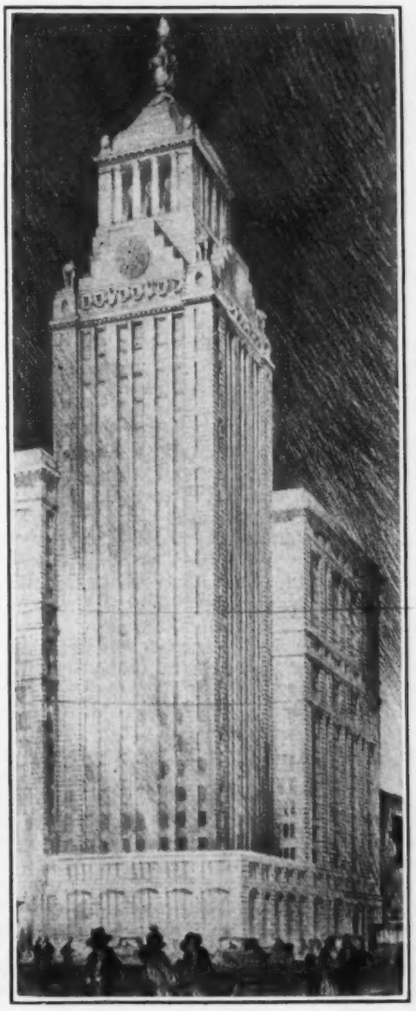
The establishment of a joint engineering board by Quebec and Ontario to investigate power possibilities of the Ottawa River, including the proposed developments at Carillon and Des Chats, has been decided upon as a result of a conference held in Quebec city recently between Premiers Ferguson of Ontario and Taschereau of Quebec.

A further step in the development scheme on the Saguenay River in the Province of Quebec was taken recently when the Duke-Price Power Company made application to the Quebec government for permission to install and operate high-tension lines between the Grand Décharge and Port Alfred. The major part of the power thus transmitted will be used at Arvida for the plants now being built by the Aluminum Corporation of America, and the remainder will be utilized for the Port Alfred Pulp and Paper Mills. Through the recent transfer of the Duke-Price interests to the Aluminum Corporation, the transmission lines will be owned by the latter company.

Power transmission wires have now been installed between the mainland—the Beaupré coast—and the Island of Orleans, in the St. Lawrence, for the Montmorency Electric Company, which will be the first to supply electricity for lighting purposes on the island. The company is developing falls on the St. Anne River, east of Ste. Anne de Beaupré, and has come to an agreement with the Shawiningan Water & Power Company to meet its needs.

That no request should be entertained for a revision of the treaty between Canada and the United States respecting the water allotment at Niagara Falls until the Chicago diversion is stopped was the declaration made recently in Toronto by C. Alfred Maguire, a member of the Ontario Hydro-Electric Power Commission, who commented on the power project for which an application has been filed with the New York State Water Power Commission by the American Superpower Corporation.

New Utility Office Building for New York City



ABOVE is shown the architect's drawing of the new Consolidated Gas Building to be erected at Fourteenth Street and Irving Place, New York City. This building, which was briefly described in the ELECTRICAL WORLD for April 17 (page 826), will be headquarters for the New York Edison Company, the United Electric Light & Power Company and associated companies. The floodlighting of the tower and the large beacon light flashing from its top will make the twenty-four-story structure stand out prominently on the sky line of New York, from whose adjacent waters it will be easily seen. Thomas E. Murray, Inc., engineers and architects, are responsible for the design of the building, which will add one more to the really notable and beautiful structures in New York City.

Grand Falls Agreement Now Completed

The legislation authorizing the development of Grand Falls on the St. John River in the Province of New Brunswick was finally disposed of by the Provincial Legislature on April 30, when the bills incorporating the New Brunswick International Paper Company and authorizing the Fraser Companies, Ltd., to construct a transmission line from Grand Falls were passed, under the guidance of Premier Baxter, together with the bill incorporating the St. John River Power Company. The power company is required within six months from the passage of the act, or within such time as the Lieutenant-Governor in Council may grant extension, to commence bona-fide construction of the hydro-electric works, and within two years from the passage of the act to expend not less than $1,000,000. Otherwise the act is null and void.

The policy of the provincial government in regard to the development of Grand Falls is summarized from official statements as follows: To eliminate the four original contracts, one of which gave the International Paper Company nearly complete control of the power; the province to be released from expending nearly $15,000,000; the $1,200,000 paid to the International Paper Company by the province to be released; the $425,000 or upward expended by the old government in preparing data to be returned with interest; the financing of the whole development to be at the cost of the International Paper Company, the province not to have a single cent of liability; 27,200,000 kw.-hr. of dependable power to be reserved to the province; a 200-ton mill to be constructed by the International Paper Company, and if there is an ample supply of power, its capacity to be increased to 700 tons a day; this work to be commenced in May, 1926, and completed in the latter part of 1928; the price of power at Grand Falls to be $20 per continuous horsepower.

No provision apparently has been made for an allotment of power to the State of Maine, where lands will be flooded and where a portion of the stream flow has its rise.

Under the provisions of the intercompany agreement, now signed, a block of 20,000 hp.—13,000 primary and 7,000 secondary—is reserved for the Fraser Companies, which will embark in the newsprint business with the construction of a mill of 200 tons daily capacity on the Restigouche River.

Jacksonville City Plant Man Explains Low Rates

The Southeastern Water and Light Association convention got under way on April 27 at the Hotel Casa Marina, Jacksonville Beach, Fla., with a record attendance and proved to be one of the most successful yet held. Frank H. Owen, Jacksonville's Commissioner of Utilities, gave a detailed talk on the city's municipally owned and operated light and water plants, asserting that they are able to give service at a low rate because of exemption from the income taxes and franchise burdens that a privately owned plant pays. C. Price, illuminating expert for the General Electric Company and Edison Lamp Works, who took the place of D. J. Finn of the General Electric Company, gave a talk on the new standard line of incandescent lamps, giving statistics and reasons for the standardization of types, wattage steps and voltages. Robert L. Totten of Birmingham stressed the necessity of designing light plants on a much larger scale than heretofore because of the unprecedented development of the Southeast.

Wednesday's sessions were taken up with discussion of water problems. On Thursday the election of officers took place, resulting in the following choice: President, E. O. Sweet, Birmingham; vice-presidents, O. Z. Taylor of Jacksonville, H. P. Powell of Griffin, Ga., R. L. Totten of Birmingham, E. M. Foster of Greenville, Miss., P. J. Scudder of Shelbyville, Tenn., B. B. Meng of Winnsboro, S. C., and C. L. Korner of Charlotte, N. C. Jackson, Miss., was selected as the meeting place for the convention of 1927.

Russia Looking to the United States for Electrical Aid

Representatives of the Russian Soviet are now in the United States seeking aid for a hydro-electric project on the Dnieper River in the Ukraine, in return either for cash or for mineral or power concessions. The plan, which has also irrigation features, calls for linking of the manganese and iron deposits in the western part of the Ukraine with the bituminous and anthracite coal fields on the east by an air-line railroad. Power for the metallurgic industries will be supplied by the Dnieper plant. The contemplated dam will, for the first time, open the Dnieper to navigation for its entire length, bringing about a waterway from the Baltic and North Seas to the Black Sea.

The Dnieper rapids above Alexandrovsk, where it is intended to build the dam, have a 110-ft. fall and are 60 miles in length. They are said to contain a potential capacity of 650,000 hp., of which it is proposed to install 300,000 hp. as the first unit, at a cost of $70,000,000, including all the features of the initial scheme. Of the power to be developed, 60 per cent is for industrial purposes. There are to be transmission lines to Ekaterinaslav, Alexandrofsky, Nikopol and to the Krivoi Rog iron ore district.

Josef A. Tzichevsky is chairman of the commission, which includes Prof. John G. Alexandroff, originator of the project, and B. K. Victoroff. All are engineers. Mr. Tzichevsky, who is a mechanical and electrical engineer and who spoke through J. G. Ohsol, vice-president of the Amtorg Trading Corporation, said the selection of this as the primary project in national electrification was because of the populous territory served and its proximity to lumber and to minerals which electric power would smelt, manufacture and in part distribute.

Sacramento Gets Report on Municipal Power Project

Three plans affecting the development of power in connection with the Silver Creek domestic water-supply project of the city of Sacramento, Cal., have been submitted to the board of directors of the municipal utility district by the engineers employed to report on the feasibility of generating energy. Plan No. 1, to cost $10,600,000, does not contemplate power development. Plan No. 2, which is estimated to cost $14,800,000, calls for the development of power at three plants along the aqueduct. These plants would have a combined capacity of 14,200 hp. and would deliver about 85,000,000 kw.-hr. annually. Revenue from this power would probably not reduce the cost of water in Sacramento to its present level, the report states. Plan No. 3 would permit the installation of 91,534 hp., which could be operated continuously for the generation of 475,000,000 kw.-hr. to 525,000,000 kw.-hr. annually. The estimated cost of this project is $27,100,000, exclusive of an electrical distribution system. The report points out that the present requirements of the district are only 40,000,000 gal. of water per day, whereas a supply of 200,000,000 gal. is contemplated by the third plan. The present consumption of power in the district is only 15,000 hp.

The engineers believe that if proper agreements can be made with power companies for the sale of energy produced under plan No. 3, water could be delivered to Sacramento for approximately the present cost. Before making any definite recommendations as to the power-plant capacities the board of consulting engineers desires information as to the possible revenue from allowing private companies to install power houses and operate under lease. Bids from the local utility companies will be solicited.

Farm Electrification in Oklahoma Starts in May

The first general farm electrification project to be launched in Oklahoma will be started in the vicinity of Pauls Valley in the present month. A farm transmission line will be constructed by the Oklahoma Gas & Electric Company and connected with its general transmission system. Nearly twenty-five farm owners along or near the route are taking an active interest in the project, and at least fifteen farms will be served. The company will furnish all materials and skilled labor and the farmers will haul the materials and provide unskilled labor.

Tripp Addresses Maryland Utilities Association

The fourth annual meeting of the Maryland Utilities Association, held at the Southern Hotel, Baltimore, on April 30, was attended by engineers and utility experts from Maryland, Pennsylvania, New York, Virginia, West Virginia and Delaware. The morning business session was devoted to round-table discussions by the electric, transportation, gas and water groups of the association, the one first named being led by Thomas Peters, general superintendent of the Potomac Edison Company. The afternoon session was opened with an address by Floyd King, head of the Virginia Utilities Association. A report on the Conowingo project was submitted by L. G. Smith, chairman of the association's hydro-electric committee. R. H. Haas, director of public relations of the Fitkin Utilities Corporation, New York City, also made an address. C. O. Culver presided at the business sessions.

At the banquet which followed Emory L. Coblentz was toastmaster. Governor Ritchie extended the official welcome to delegates and guests, and Herbert A. Wagner, president of the Consolidated Gas, Electric Light & Power Company, spoke on "Public Utilities and the State."

The chief address was that of General Guy E. Tripp, chairman of the board of the Westinghouse Electric & Manufacturing Company, who dealt with "Farm Problems." Declaring that farmers were not inefficient but were the victims of "economic unbalance," General Tripp predicted agricultural prosperity, based on electric service, saying:

"Conditions now are indeed favorable to a distribution of industries throughout the country. Electric superpower development makes it possible, and there already is in evidence a considerable movement in this direction. If this goes on, it will be beneficial to the farming industry in that it will furnish employment to the rural population which will tend to make the farmer's family in part industrialistic and thus, in some degree, overcome his unfavorable position as a competitor with the industrial worker, who works full time while the farmer's efficient work is intermittent, owing to the seasonal nature of his industry.

"I really believe," the speaker concluded, "that the agricultural situation is the present frontier of the electric light and power industry; and in view of the fundamental importance of the problem I have described, no more fatal mistake could be made than for the government to place its dead hand upon a development which has the possibilities and even the probabilities of being the largest factor in restoring the balance between industry and agriculture."

Officers for the ensuing year were elected as follows: President, R. Paul Smith, Frederick, Md.; vice-president, H. B. Potter, Baltimore; treasurer, H. T. Connolly, Baltimore; secretary, H. L. Shindledecker, Baltimore; directors, Charles M. Cohn, C. O. Culver, L. T. Mayers, A. W. Tawes, G. W. Woolford, and H. A. Brooks.

Technical Work on Coast

Committees of Electrical Associations Report Active and Productive Year's Work

AN ACTIVE and productive year's work of the technical committees of the Pacific Coast Electrical Association was brought to a close at a conclave meeting held at Fresno, Cal., April 7-9. This meeting followed one held in March at Seattle by the Technical Section of the Northwest Electric Light and Power Association, where an excellent two-day program was carried out and progress recorded in many directions, including accident prevention, inductive co-ordination and the work of the committees on hydraulic power, apparatus, overhead and underground systems, meters and prime movers. The registration of 150 at the Seattle meeting showed a record attendance.

This attendance was exactly duplicated at the Fresno meeting, which was probably the largest ever held by the Technical Section of the Pacific Coast association. Delegates to the recent meeting of the Technical National Section in Kansas City brought back with them information concerning Eastern practice which will prove of value to Pacific Coast operating men and engineers. William Baurhyte, president of the Pacific Coast association, addressed a luncheon meeting on the value of the work of the Technical Section to the association and the industry.

Discussion of the subject of insulated versus bare wire in the overhead systems committee brought out the fact that the insulation on wire is practically worthless after the wire has been in service several years, but not withstanding this fact most operating companies favor the use of insulated wire for city work. However, the saving of approximately 10 per cent which may be effected by using bare wire has led to its quite general use in rural construction. The study of treated and untreated poles by the committee has shown that the bug known as the termite is much more prevalent than had been realized. Investigations thus far made seem to indicate that full-length treatment of the poles is desirable, as well as treatment of the crossarms and wooden pins.

In the apparatus committee the oil circuit breaker came in for a thorough discussion. Several speakers brought out the necessity for greater care on the part of manufacturers in designing mechanical parts of breakers to overcome the trouble which is experienced in the field with contacts, arcing tips, tripping and operating mechanisms, etc. Operating men were of the opinion that the most important factor entering into the high interrupting capacity of oil switches is the speed of break.

During the year the hydraulic power committee has added notable information on the subjects of water hammer and hydraulic equipment troubles. The work of R. S. Quick of the Pelton Water Wheel Company has resulted in the production of a chart from which the maximum value of the pressure rise readily can be determined in a few minutes where the old step-by-step arithmetical integration method took as many hours. An interesting study on the mechanical reliability of hydro plants was presented by E. A. Crellin, in which the causes of outages were analyzed with respect to three types of machines—impulse wheels, vertical reaction turbines and horizontal reaction turbines.

In the discussion of radio interference in the inductive co-ordination committee it was stated that the Pacific Radio Trades Association is starting a campaign which will take care of many troubles not caused by the power companies, though commonly attributed to them. Although this work will be carried on only in the larger cities, the co-operation of local dealers in the small towns is beginning to show promising results.

The safety rules committee discussed the possibility of standardizing on a definite test device, and it was suggested that at least an endeavor be made to take definite action on a switch providing testing facilities for installations requiring switches up to and including 100-amp., 600-volt capacity. A resolution was passed unanimously favoring incorporating isolation test devices on switches up to and including 100 amp., 600 volts capacity. This represents a definite accomplishment and gives a basis upon which to build future action.

Final reports on condensing equipment, burning of liquid and gaseous fuels, heat balance and auxiliaries were read and discussed in the prime movers committee. Important subjects taken up in the underground systems committee were transformer vault location and design for heavy loads, electrolysis, maintenance of leadless submarine cables and methods of detecting trouble in such cables.

Southeastern N.E.L.A. Elects New Officers

At the conclusion of the annual convention of the Southeastern Division, N.E.L.A., at Pinehurst, N. C., last week the following officers were elected for the coming year: President, B. C. Edgar, vice-president and general manager Tennessee Electric Power Company; first vice-president, Joe H. Gill, vice-president Florida Power & Light Company; second vice-president, Charles A. Collier, sales manager Georgia Railway & Power Company; third vice-president, E. H. Ginn, manager Atlanta district General Electric Company. The following executive committee was elected: T. H. Tutwiler, Memphis; Thomas Bragg, Birmingham; S. C. Cooper, Charleston, S. C.; J. V. Strange, Raleigh, N. C.; Thomas Hanlon, Tampa, Fla.; P. S. Arkwright, Atlanta; Howard Hall, Atlanta; H. A. Coles, Atlanta; H. E. Cox, Birmingham.

Organize for Pure Research in Science

Representatives of universities, research institutions, foundations supporting research efforts, commercial laboratories and national scientific societies met at the University of Pennsylvania last Monday and made plans for a comprehensive national survey of research possibilities in pure science. The conference laid the groundwork for a general, formal conference next fall, the call for which will be prepared by a committee of seven representatives of universities and an advisory committee of seven representatives of other research organizations.

The conference approved the plan of the National Academy of Sciences, as expressed through the National Research Endowment, under the leadership of Secretary Hoover, Elihu Root and Charles E. Hughes, to raise $20,000,000 to aid American universities in carrying on fundamental research during the next ten years. Dr. Vernon Kellogg of the National Research Council represented Secretary Hoover. Among technical men present were Alfred D. Flinn, General John J. Carty, William C. L. Eglin, W. R. Whitney and Prof. M. I. Pupin.

Briefer News

A. M. E. S. to Meet at Hot Springs, Va., in June.—Meetings of the sections of the Associated Manufacturers of Electrical Supplies are scheduled for the mornings of June 7 to June 11 inclusive at The Homestead, Hot Springs, Va. The association will hold its annual meeting in two sessions on Tuesday and Wednesday evenings of that week. All the afternoons will be devoted to golf.

Stone & Webster Buy New Office Home.—Stone & Webster, Inc., Boston, have purchased the Massachusetts Trust Company Building, at Devonshire, Franklin and Federal Streets, and will occupy this structure in the near future as lease arrangements with existing tenants permit. The present home of the company at 147 Milk Street ultimately will be vacated, and the plan for a new building at Kilby and Water Streets has been given up.

New Plant Dedicated at Leavenworth, Kan.—Citizens of Leavenworth, Kan., took an active part in the dedication of the steam generating station just completed at that point by the Kansas Electric Power Company, an Albert Emanuel subsidiary. The new plant has an operating capacity in excess of 7,500 kw. A spray pond supplies cooling water at the rate of 30,000 gal. per minute. Private bathrooms, showers and first-aid equipment are features of the new station.

Building a Transmission Line Through the Back Country of Quebec Province.—Discussing the preparations for the construction of a 165-kv. transmission line either from Ile Maligne, on the Saguenay River, to Quebec City or from Ile Maligne to Shawinigan Falls, Julian C. Smith, vice-president and general manager of the Shawinigan Water & Power Company, which is to use 100,000 hp. from the Saguenay, said the other day: "We have already a few men trying to push through a survey for the line through the north country, but so far they are not progressing very fast on account of adverse climatic conditions. We will probably have

four or five hundred men working on construction this summer, and it will take about a year to put the line through. Its cost will be $4,000,000. The line will traverse with 90-ft. steel towers the wild plateau of Laurentide Park, crossing the height of land, and will, when completed, be one of the highest-powered transmission lines on the North American Continent."

Chicago Electric Association Has Big Luncheon Meeting.—The Electric Association of Chicago held its first big luncheon in the new Palmer House on Thursday, April 22, with a great gathering of electrical men. B. E. Sunny, chairman of the board, Illinois Bell Telephone Company, and J. R. Lovejoy, vice-president General Electric Company, made notable talks. John F. Gilchrist, president of the Electric Association and vice-president of the Commonwealth Edison Company, presided.

Manhattan, Kan., Has Electrical Exhibit.—Twelve thousand persons visited a three-day industrial exhibit sponsored by the Manhattan (Kan.) Chamber of Commerce recently wherein electricity and electrical devices played an important part. Credit for the success of the enterprise was given by Chamber officials to Arthur Groesbeck, manager of the United Power & Light Corporation in Manhattan. A feature of the electrical exhibit was a complete generating station and distributing system in miniature, showing the conversion of coal to electricity and its application to many varied uses.

Montana Power Company's New Eagle Falls Plant. — The 25,000-hp. hydro-electric plant which the Montana Power Company is, as already reported, building at Black Eagle Falls on the Missouri River near Great Falls, Mont., will replace an 8,000-hp. plant built in 1890 by the Boston & Montana Smelter. The new plant will contain three propeller-type vertical turbines, the largest of their kind yet installed, operating under a head of 25 ft. with a guaranteed efficiency of 90 per cent. In reconstructing the present timber crib dam it will be necessary to make provision for bypassing the unusually large flow of 100,000 sec.-ft. of water. The plant is scheduled for completion during the summer of 1927.

Ripon (Wis.) Rural Experiment to Be Extended. — Wisconsin's farm electric experiment is going to be greatly enlarged if plans now being considered by electric companies are favorably acted upon, and preliminary expressions of opinion indicate they will be, according to R. G. Walter of Madison, chairman of the rural electric service committee of the Wisconsin Utilities Association. "Instead of confining experimental work exclusively to the Ripon test line," said Mr Walter. "It is proposed to establish experimental farms in different parts of the state. Each company will designate from one to four farms in its territory as electric farm laboratories. All experiments will be under the supervision of the Agricultural College of Wisconsin University. In this manner the experience on the Ripon line will be multiplied and the knowledge of what electric service can do on the farm will receive more general dissemination. Some companies plan to floodlight the farms by night. The Milwaukee Electric Railway & Light Company, Wisconsin Public Service Corporation, Northern States Power Company, Wisconsin Valley Electric Company, Madison Gas & Electric Company and the Southern Wisconsin Electric Company are among those interested."

A New Mid-Western System.—In acquiring the Minnesota Electric Distributing Company, as recorded under "Purchases and Mergers" last week, and uniting it with the Interstate Power Company, the Utilities Power & Light Corporation provides a new large interconnected system in the Middle West. For a distance of approximately 400 miles a complete tie-up will be effected, extending from Clinton, Ill., on the east, to Cody, Neb., and Winner, S. D., on the west. A 110,000-volt transmission line already connects Clinton and Dubuque, and through new connections the remainder of this portion of the system will be similarly linked. The Minnesota Electric Distributing Company controlled the People's Light & Power Company of Lamberton, Minn.; the Red River Valley Power Company of Crookston, Minn.; the Minnesota Electric Light & Power Company of Bemidji and other properties supplying electricity up to the Canadian frontier and in wholesale quantities to two Manitoba towns.

Coming Meetings of Electrical and Allied Societies

[A complete directory of electrical associations, with their secretaries, is published in the first issue of each volume. For latest list see ELECTRICAL WORLD, Jan. 2, page 80.]

National Fire Protection Association—Atlantic City, N. J., May 10-13. F. H. Wentworth, 40 Central St., Boston.

Electrical Manufacturers' Club — Hot Springs, Va., May 12-15. W. F. Field, Safety Cable Co., New York.

National Electric Light Association—Atlantic City, N. J., May 17-21. M. H. Aylesworth, 29 West 39th St., New York.

National Electrical Credit Association —New York, May 20-21. F. P. Vose, 1008 Marquette Bldg., Chicago.

Electric Power Club—The Homestead, Hot Springs, Va., May 24-27. S. N. Clarkson, Keith Bldg., Cleveland.

American Institute of Electrical Engineers—Regional meeting, Niagara Falls, N. Y., May 26-28; annual convention, White Sulphur Springs, W. Va., June 21-25. F. L. Hutchinson, 33 West 39th St., New York.

American Association of Engineers—Philadelphia, June 1-6. M. E. McIver, 63 East Adams St., Chicago.

Electrical Supply Jobbers' Association —The Homestead, Hot Springs, Va., June 2-4. F. Overbagh, 411 South Clinton St., Chicago.

Associated Manufacturers of Electrical Supplies — The Homestead, Hot Springs, Va., June 7-11. F. Nicholas, 30 East 42d St., New York.

North Central Division, N.E.L.A.—St. Paul Hotel, St. Paul, June 8-10. J. W. Lapham, 351 Loeb Arcade, Minneapolis.

Pacific Coast Division, N.E.L.A.—Biltmore Hotel, Los Angeles, June 8-11. S. H. Taylor, 447 Sutter St., San Francisco.

Northwest Division, N.E.L.A. — Spokane, Wash., June 14-17. L. A. Lewis, Washington Water Power Co., Spokane.

New Office Building for Northern States Power in Minneapolis. — The Northern States Power Company has taken a hundred-year lease on a piece of property at 21 to 23 Fifth Street South, Minneapolis, with 44 ft. frontage adjoining its present headquarters in the heart of the Minneapolis "loop," and will erect a twelve-story modern office building, to be known probably as the Electrical Building. The company is planning also to add seven stories to its present building to make its height uniform with the new structure.

New Power Plant on American River Planned by California Companies. — Construction in central California of a power plant to cost $3,659,000 and develop 24,859 hp. is planned by the El Dorado Water & Power Company under a permit just granted by the state to divert 7,500 acre-ft. of water from Silver Fork of the South Fork of the American River. Two other permits give the El Dorado company and the Western States Gas & Electric Company, allied in the development of water power projects on the American River, the right to divert this storage water for use at established plants lower down the stream. Authority is granted to increase the capacity of the El Dorado plant of the Western States Gas & Electric Company to 122,564 hp., an increase of 30,641 hp. Other improvements will raise the capacity of the American River plant of the same company to 27,982 hp., an increase of 9,762 hp. Power from both plants is used to serve the cities of Lodi and Stockton, Cal.

Engineers Report Unfavorably on Wynooche Municipal Project.—Reporting to the city of Aberdeen, Wash., on the feasibility of developing hydro-electric power in connection with a proposed domestic water supply from the Wynooche River, Stevens & Koon, consulting engineers, estimate that a plant of 24,000-hp. capacity would cost $4,797,000 and that a total capital investment of $5,551,000 would be required before the plant would begin to pay its own way. Cost of establishing business and financing deficits of the early years of operation is placed at approximately $1,000,000. At present there is a market for about 15,000,000 kw.-hr. in Aberdeen and the Grays Harbor district, and to obtain any of this load the city would be in competition with the Grays Harbor Railway & Light Company. Municipal plants in Washington have no legal right to serve customers outside their limits. If the city means to enter the power business, the engineers advise either the construction of a steam plant or building a transmission line to the Cushman municipal plant of Tacoma and buying power wholesale. Refusing to accept these findings, the Aberdeen City Council has employed W. J. Roberts, a consulting engineer of Tacoma, to make a new report. The Council agreed to delay for two weeks submitting to the voters a bond issue for $2,000,000 to build the plant.

Recent Court Decisions

Erection Without Official Permission of Electric Power Poles on Roadway Passing Through Another's Land Is Trespass. — One Armstrong sued the Pinnacle Coal & Coke Company for compensation for trespass because the company, without his permission, erected on his land poles for transmitting electricity. The West Virginia Supreme Court of Appeals found insufficient the company's plea that the poles were on a roadway and that the plaintiff had offered no objection at the time they were set up. The court found that the erection of such poles imposed an additional burden upon the owner of the land, who was entitled to damages. (131 S. E. 712.)*

Employee on Way to Work Held "in Course of Employment" When Attempting to Remove Dangerous Wire.—The Kentucky Court of Appeals sustained the award of damages to the family of an employee of a coal company who while on his way to work picked up an electric wire lying across the path and was killed in attempting to remove it (Harlan Gas Coal Company vs. Trail). The wire belonged to and was maintained by the Kentucky Utilities Company and was used to transmit power to the coal company's mine. The coal company maintained that it had no responsibility, but the court held that the man acted in the course of his employment, since the fallen wire was a source of danger which a loyal employee would be expected to remove. The fact that a fellow employee advised him not to touch the wire did not make his doing so "willful misconduct," as claimed by the appellant. (280 S. W. 954.)

What Is Implied in Acquisition of a Right-of-Way?—The Kentucky Court of Appeals reversed the trial court in Kentucky & West Virginia Power Company vs. Elkhorn City Land Company, a suit over the value of a right-of-way, because the trial judge had told the jury that "the plaintiff has an easement or privilege in the strip of land sought to be condemned for the purpose of erecting, operating and maintaining thereon towers, poles, wires and fixtures, to be used as a transmission line in transmitting electric and other power, including a telephone and telegraph line, and the plaintiff has the exclusive right to said easements and privileges if it sees fit to exercise them, and the defendant has no right to use said strip of land sought to be condemned for any purpose inconsistent with said right." The appellant insisted that this instruction was erroneous because it implied that the power company had the right to the exclusive possession of the strip sought to be condemned, which right it might exercise capriciously if it so elected, and that this implication was the one put upon it by the jury in the light both of a question it asked, to which the instruction was responsive, and of the size of the verdicts returned. Sustaining the objection, the Court of Appeals decreed that "on a retrial of the cases the court will instruct the jury as to the character of the easement sought to be condemned and will inform it that the land owner may in all respects use the strip of land over which the easement passes so that such use does not interfere with the reasonable and prudent exercise and enjoyment by the power company of the easement it is seeking to acquire."

*The left-hand numbers refer to the volume and the right-hand numbers to the page of the National Reporter System.

Interstate Company Allowed to Include Oregon Property in Valuation of Washington Division. — The Superior Court of Washington State has handed down a memorandum opinion having the effect of reversing an order of the Washington Department of Public Works by which the rate base of the Pacific Power & Light Company, Portland, was reduced, and formal judgment will remand the case to the department for further action. The commission's order (see ELECTRICAL WORLD for Jan. 23, page 222) reduced the value of the company's Yakima-Walla Walla power system by $1,137,244. The largest reduction was for certain generating and transmission property in Oregon which, it was contended, had been erroneously included in the Washington rate base fixed by a previous order—the cities of Yakima, Walla Walla and others having alleged a "palpable error" in this connection. The court agreed with the company's contention as to the Oregon properties, sustaining the original valuation.

California Plant of Utility Company Not Operating in That State May Be Taxed by County Containing It.—In Nevada-California Power Company and Pacific Power Corporation vs. James Borland, the two power corporations, which operated as public service corporations in Nevada, generated electricity at plants in Mono County, Cal., and transmitted it through California into Nevada, but did not generate, transmit or sell electric power for use in California. Their articles of incorporation provided "that the corporations shall not do a public utility business in the State of California or serve the public in any way within the territorial limits of such state." The assessor of Mono County assessed the hydro-electric generating plant, the land on which it was situated, water and water rights and electrical transmission lines situated in said county. The tax was not paid and the properties were advertised and declared sold to the state for the taxes for the year 1916. The power companies brought action to enjoin the execution of the deed after said sale for the non-payment of the county taxes. From a judgment for the defendants the companies appealed to the California District Court of Appeals, which has affirmed the judgment of the lower court. The court held that the corporations were not public utilities within the meaning of the constitutional provision providing that taxes based on gross receipts and paid to the state by companies engaged in the transmission or sale of gas or electricity shall be in lieu of all other taxes and licenses, state, county and municipal.

Commission Rulings

Single Owner of Two Meters in One Building Entitled to Benefit of Step Rates on Total Consumption.—The Oklahoma Corporation Commission has ordered the Oklahoma Gas & Electric Company to refund to the owners of the Grain Exchange Building, Oklahoma City, the sum of $2,767, alleged overcharges from June 8, 1921, to Sept. 18 1924. Service in the building has been rendered through two electric meters, which were originally installed to serve two separate lessees. Later the building was placed under one management, but the two meters remained. The owners alleged that two separate bills were presented each month, preventing them from reaping the benefit of the lower step rates and that they should have the benefit of these lower rates even though service was rendered over two meters. This contention was sustained by the commission as reasonable and proper.

Comparisons of Rates in Different Communities Must Show Similar Conditions.—The Public Service Commission of New York has denied the petition of the city of Plattsburg to reopen the rate case of the Plattsburg Gas & Electric Company, without prejudice to renewal if certain proposed consolidations and mergers of the Plattsburg company and other electrical companies named in the petition be consummated and approved by the commission. The city said that the Associated Gas & Electric Company owned or controlled the Plattsburg company, the Chasm Power Company of Chateaugay and the Champlain Electric Company and that the electric rates in the territory of the two other companies were lower than in Plattsburg and that the company intended to send energy from Plattsburg to Rouse's Point and other points in northern New York to be sold at lower rates than those obtaining in Plattsburg. Applications are pending for permission to transfer the Champlain and Chasm companies to the Plattsburg company, but the commission said that none of these consolidations has been consummated and that all the corporations mentioned have been and still are separate corporate entities; that the only energy furnished to any of the other companies by the Plattsburg company was a standby service to make up for any deficiency in energy generated by these companies by water power, and that no part of the value of the transmission line for this standby service was inventoried in the property from which a return was asked by the Plattsburg company. The commission said further: "It would seem to be settled law in this state that comparisons of rates for gas and electricity in different municipalities of the state are not competent and material evidence to be considered in fixing the rates in any one particular municipality unless it is shown that the conditions surrounding the cost of production and distribution are comparable."

Financial and Corporate

Utility Market Irregular

Preferred Issues Strengthen, but Common Stocks Fail to Hold in General List

ONE of the more interesting aspects of the market in public utility stocks during the week under review was the increased interest in the preferred issues. Continued general ease in the money position was responsible for considerable switching into investment issues, and nowadays investors manifest a new confidence in the sound preferred stocks as well as in the seasoned power and light bonds.

Among the preferred stocks of the power and light group that showed special strength during the week were Alabama Power preferred, Electric Bond & Share preferred, Galveston-Houston preferred, National Power preferred, Penn-Ohio Securities preferred, Western Power preferred and others of that general character.

In the market for common stocks of the utility group the net changes for the week represented a mixture of gains and losses, although the losses perhaps outnumbered the gains. Columbus Electric & Power was one of the strongest issues in the market from the standpoint of net advance recorded, having improved in position by fifteen points. A three-point advance for the week in United Gas Improvement was accompanied by increased activity in that issue.

Small losses were recorded by the following common stocks in the liquidation that appeared on reports of the labor crisis in Great Britain and which affected the whole market: Galveston-Houston Electric, American Light & Traction, American Power & Light, Southeastern Power & Light, Commonwealth Power Corporation, Electric Investors, Inc., Middle West Utilities, Northern States Power.

New Capital Issues

During the first week of May new offerings of electric light and power securities totaled $10,266,000. The largest individual flotation was made by the Utica Gas & Electric Company in the form of 5 per cent general mortgage gold bonds, series D, amounting to $6,000,000. These bonds were priced at 100 and interest and mature April 1, 1956. The Florida Public Service Company made an offering of first mortgage 6 per cent gold bonds, series B, at 98 and accrued interest, to yield about 6.15 per cent, a piece of financing involving a total of $1,766,000.

Cumulative preferred stock to the amount of $2,500,000 was issued by the Utilities Power & Light Corporation, the price being $95 per share and accrued dividend to yield about 7.35 per cent. Proceeds will provide in part for expenditures made in connection with additional investments in subsidiary companies, including the acquisition for the Interstate Power Company of the Minnesota Electric Distributing Company and subsidiary and associated properties.

Bonds Called in May.—Among the securities called for payment in May in advance of maturity are the following:

Issues	Due	Amount
Manitoba Power 7s.	1941	$7,500,000
Cities Service deb. 7s. C.	1966	5,066,560
Carolina Power & Light 6s.	1953	4,800,000
Manila Electric 7s.	1942	3,419,300
West Virginia Water & Electric 6½s.	1942	3,300,000
Municipal Service 6s.	1928	3,250,000
Empire District Electric 8s.	1949	1,762,000
Electric Public Service 5s.	1926	1,000,000
Virginia - Western Power 6s.	1926	1,000,000
Northern States power 6½s.	1933	186,400
United Power & Light 6½s.	1926	125,000
Denver Gas & Elec. 5s.	1949	58,100
Power Corp. of New York 6½s.	1942	12,000

Boston Edison Issues Annual Report

The annual report of the Edison Electric Illuminating Company of Boston for the fiscal year ended Dec. 31, 1925, shows electric operating revenues amounting to $21,315,241 as compared with $19,494,784 for the corresponding period of the previous year. Electric operating expenses amounted to $9,840,878 as compared with $9,333,352, leaving net operating revenue of $11,474,363 in 1925 against $10,161,432 in 1924.

Total kilowatts connected Dec. 31, 1925, amounted to 652,342, an increase of approximately 62,000 kw. over the total recorded as of Dec. 31, 1924. During the year the number of customers increased 31,870, or approximately 15 per cent, making the total number 242,320.

Big Utility Serves from Coast to Coast

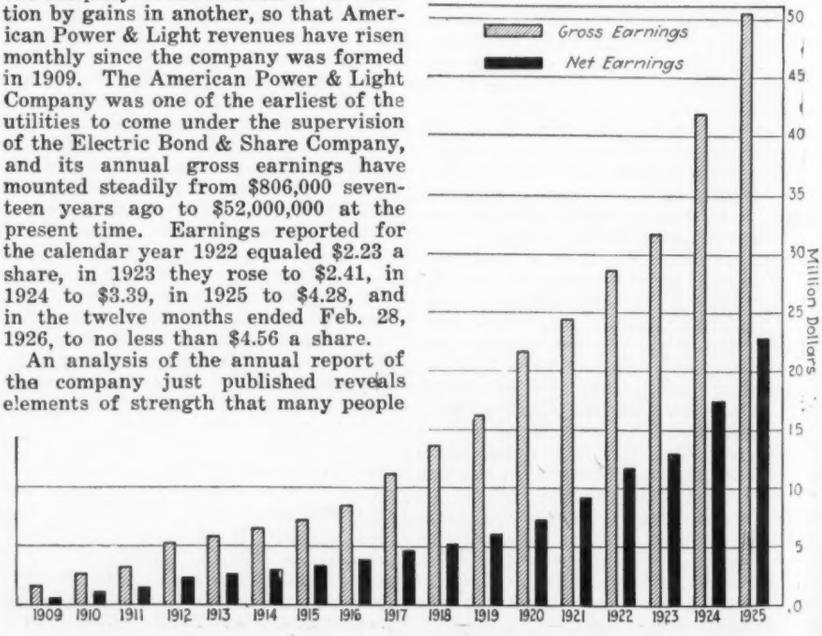
American Power & Light Company, Which Now Has Gross Earnings of $52,000,000, Is a Model of Diversification—Revenues Have Gained Monthly Since 1909

BY PAUL WILLARD GARRETT
Financial Editor *New York Evening Post*

PERHAPS no utility of its kind in the world serves so diversified a territory as the American Power & Light Company, for its subsidiaries may be found in sections as widely separated as Florida on the Eastern coast and Washington on the Western coast or as Minnesota to the north and Texas to the south. That unusual diversity has for a long period enabled the company to offset losses in one section by gains in another, so that American Power & Light revenues have risen monthly since the company was formed in 1909. The American Power & Light Company was one of the earliest of the utilities to come under the supervision of the Electric Bond & Share Company, and its annual gross earnings have mounted steadily from $806,000 seventeen years ago to $52,000,000 at the present time. Earnings reported for the calendar year 1922 equaled $2.23 a share, in 1923 they rose to $2.41, in 1924 to $3.39, in 1925 to $4.28, and in the twelve months ended Feb. 28, 1926, to no less than $4.56 a share.

An analysis of the annual report of the company just published reveals elements of strength that many people not familiar with the utility's rapid growth may not have appreciated. Total assets of the company have grown to the sizable aggregate of $83,373,402, for example, and current assets total $15,314,990, whereas current liabilities total only $614,184.

The capital structure of the American Power & Light Company is one that appeals to stockholders in that



STEADY GROWTH OF AMERICAN POWER & LIGHT EARNINGS SINCE 1909

the bonded indebtedness is not excessive and that such bonds as now are outstanding do not mature until the distant future. The company's only funded debt until recently consisted of $35,912,400 debenture bonds that do not mature until 2016. Another series of these long-term debentures, amounting to $10,000,000, increases the debt, but the total remains at a conservative figure when account is taken of the enormous assets of the company.

The American Power & Light Company owns substantially all of the common stocks and in some cases various amounts of preferred and second preferred, as well as bonds of the following utilities that represent the more important members of its group: (1) Kansas Gas & Electric Company, (2) Nebraska Power Company, (3) Minnesota Power & Light Company, (4) Superior Water, Light & Power Company, (5) Pacific Power & Light Company, (6) Northwestern Electric Company, (7) Portland Gas & Coke Company, (8) Florida Power & Light Company, (9) Central Arizona Light & Power Company, and (10) Southwestern Power & Light Company.

Stock and Bond Quotations of Electric Light and Power and Manufacturing Companies

(Prices on New York stock market unless otherwise noted. Unless otherwise noted the par, stated, or preferenes value of stock is $100.)

Companies	Bid Price Saturday May 1	Low 1926	High 1926
STOCKS			
ABITIBI PWR. & PAPER, com. —no par	k 73	71¼	84¼
Adirondack Pwr. & Lt.—7% pf.	k101¼	....	....
Adirondack Pwr. & Lt.—8% pf.	109	108	110
Ala. Pwr., pf.	k105	....	....
Allis-Chalmers Mfg. pf.	k109	105	110
Allis-Chalmers Mfg., com.	82	78¼	94¼
Aluminum Co. of Amer., com.	k 64	54½	76
Aluminum Co. of Amer., new, pf.	k 93	....	....
Amer. & Foreign Pwr., pf. 25% pd.	m108	108	131
Amer. & Foreign Pwr., 7% pf.—no par	90½	89	98
Amer. & Foreign Pwr., com.—no par	k 18½	17	42¼
Amer. Bosch Magneto, com—no par	k 19½	19½	34¼
Amer. Brown Boveri, Elec.	k 36	30½	48¼
Amer. Brown Boveri Elec. pf.	k 95	86½	97½
Amer. Elec. pwr., pf.	c111½	102½	111½
Amer. Gas & Elec., 6% pf.—no par.	k 90½	....	....
Amer. Gas & Elec., com.—no par.	k 72½	64	99¼
Amer. Lt. & Trac., 6% pf.	107	114½	115½
Amer. Lt. & Trac., com.	m204	195	263
Amer. Pwr. & Lt., 6% pf.	k 93½	92	96
Amer. Pwr. & Lt., com.—no par.	k 52¼	48½	79½
Amer. Pub. Serv., 7% pf.	k 94	....	....
Amer. Pub. Serv., com.	47	45	80
Amer. Pub. Utilities, 6% pf.	82	85	86
Amer. Pub. Utilities, 7% pf.	k 88	....	....
Amer. Pub. Utilities, com.	70	80	82
Amer. States Sec., A	k 2½	....	....
Amer. States Sec. B	k 24½	21½	....
Amer. Superpwr., pf.—25	25	23	26½
Amer. Superpower, pf.	91½	90	94
Amer. Superpwr., Class A—no par.	23½	19½	37½
Amer. Superpwr., Class B—no par.	25	21½	39
Amer. Wtr. Wks. & Elec., 7% pf.	105	101¼	108½
Amer. Wtr. Wks. & Elec., com.—20.	k 49	43½	74
Anaconda Copper	k 46½	41½	51
Appalachian Pwr., 7% pf.	100	99	101
Appalachian Pwr., 1st pf., 7%	100	99	101
Appalachian Pwr., com.	80	80	83
Arizona Pwr., 7% pf.	k 75	....	....
Arizona Pwr., com.	m 27	27	35½
Arkansas Cent. Pwr., pf., $7—no par	102	99	102
Arkansas Lt. & Pwr., 7% pf.	96	96	102
Arkansas Lt. & Pwr., com.	100	110	115
Asheville Pwr. & Lt., 7% pf.	f104	100½	104
Assoc. G.&E., pf.—$3.50—50	k 50	....	....
Assoc. Gas & Elec., pf.—$6—no par	k 82½	....	....
Assoc. Gas & Elec., Class A—no par	k 29½	25½	35½
BABCOCK & WILCOX, com.	k114	114	149
Binghamton Lt., Ht. & Pwr., pf.	105	....	....
Birmingham Elec. pf.—$7—no par.	102	101	103½
Blackstone Valley Gas & Elec., pf.	92	90	106
Blackstone Valley G.&E., com.—50.	90	....	....
Blaw-Knox, com.	m 48	45	56
Brazilian Trac., Lt. & Pwr., com.	f 87½	....	....
Broad River Pwr., pf.	k 93	....	....
Brooklyn Edison, com.	k139	133	146½
Buffalo,Niagara & East.Pwr.,pf.—25	k 24½	....	....
Buffalo, Niagara & Eastern Pwr., com.—no par.	k 27	....	....
CALIFORNIA ELEC. GENERATING, pf.	90	89	93
California Ry. & Pwr., pf.	105	88	115
Carolina Pwr. & Lt., pf.—$7—no par	103	102	107
Cent. & S. W. Ut. 7% pf.—no par	a 93	89½	95
Cent. & S. W. Ut., pr. ln. pf.—no par	a 97	95½	100
Central Ariz. Lt. & Pwr., pf.	102	....	....
Central Ark. Ry. & Lt., 7% pf.	k 98	....	....
Central Ill. Pub. Serv., 6% pf.	88	89	91
Central Ind. Pwr., 7% pf.	88	88	93½
Central Pwr. & Lt., pf.	94	94	98½
Central States Elec., 7% pf.	k 93	....	....
Central States Elec., com.	m200	200	220
Century Elec., com.	b115	110	116
Chicago Fuse Mfg., com., no par.	a 33½	30½	35
Cincinnati Gas & Elec., com.	g 90½	88	95½
Cities Service, 6% pf	k 84	....	....
Cities Service, pf.B—10.	k 7½	....	....
Cities Service, pf. BB—100.	k 74	....	....
Cities Service, com.—20.	k 41½	....	....
Citics Service, Bks. Shrs.—10.	k 19½	....	....
Clarion River Pwr., pf.	93	93	95
Cleveland Elec. Illg., 6% pf.	105	103	105
Cleveland Elec., Illg., com.	k225	....	....
Colorado Pwr., 7% pf.	k 96	....	....
Columbia Gas & Elec., 7% pf.	k112½	112	115
Columbia Gas & E., com.—no par.	k 75½	63½	90
Columbia Ry., Gas & Elec., 6% pf.	95	95	96
Columbus Elec. & Pwr., 2d pf.	k102	....	....
Columbus Elec. & Pwr., com.	k215	....	....
Columbus Ry., Pwr. & Lt., 1st. pf.	97	98	99
Columbus Ry., Pwr. & Lt., pf. B.	95	92	95
Col. Ry., Pwr. & Lt., com.—no par.	82	82	85
Commonwealth Edison, com.	a139½	137½	144
Commonwealth Pwr., 6% pf.	k 84½	82	87
Commonwealth Pwr., com—no par.	k 33½	28½	42½
Conn. Lt. & Pwr., 8% pf.	116	117	121
Conn. Lt. & Pwr., 7% pf.	108	108	113
Cons. Gas of N. Y., pf.—50.	k 57½	....	....
Cons. Gas of N.Y., com.—no par.	k 93½	87	104½
Cons. Gas Elec. Lt. & Pwr. of Balti., 6% pf.	e103	102	105
Cons. Gas, Elec. Lt. & Pwr. of Balti 6½% pf.	e110	108½	110
Cons. Gas, Elec. Lt. & Pwr. of Balti., 7% pf.	e112	109	115½
Cons. Gas, Elec. Lt. & Pwr. of Balti. 8% pf.	e126½	124	128½
Cons. Gas, Elec. Lt. & Pwr. of Balti. com.—no par.	e 50½	45	57½
Cons. Pwr. & Lt., 7% pf.	104	100	107
Consumers Pwr., 6% pf.	97	95	98
Consumers Pwr., 6.6% pf.	102	101½	103½
Continental Gas & Elec., 7% pfc. pf	k 97½	....	....
Continental Gas & Elec., 7% pr. pf.	k 94½	....	....
Continental G.&E., com.—no par.	100	85	150
Crocker Wheeler, com.	14	14	19
Crocker Wheeler, pf.	50	50	55
DALLAS PWR. & LT., 7% pf.	102	102	104
Dayton Pwr. & Lt., 6% pf.	98½	95	97
Detroit Edison, com.	k128½	123½	141½
Dubilier Condenser & Radio, com. no par.	k 4½	4½	11
Dubuque Elec., 6% pf.	97	93	97
Duquesne Lt., 7% pf.	k114½	111½	116½
EAST. N. Y. UTIL. pf.	80	80	85
Eastern New York Util., com.	65	70	75
Eastern States Power.	16	23	32½
Eastern States Pwr.,pf.	k 87	....	....
Eastern Tex. Elec., 7% pf.	k102	....	....
East. Tex. Elec., com.—no par.	102	103	107
Edison Elec. Illum. of Boston, com.	d215	207	250
E. Paso Elec., com.—no par	300	290	318
E. Paso Elec. pf.	101	102	104
Elec. Bond & Share, 6% pf.	f106	103½	107½
E. Bd. & Share Sec., com.—no par.	f 67½	56½	86
El. Household Util.	a 18	16½	25
Elec. Investors, 6% pf.—no par.	89	92	95
Elec. Investors, com.—no par.	k 36½	30½	74½
Elec. Investors, 10% pd. receipts.	20	....	....
Elec. Pwr. & Lt., ctfs., pf.	k 93½	89½	97½
Elec. Pwr. & Lt., ctfs., 40% pd.	102	99½	115
Elec. Pwr. & Lt., ctfs. full pd.	107	103	110½
Elec. Pwr. & Lt., ctfs., com.—no par	k 19	17½	34½
Elec. Ry. Securities, com.—no par.	6	4½	10
Elec. Refrig.	k 64½	63	90½
Elec. Storage Battery, com.—no par.	k 76½	71½	79½
Elmira Wtr., Lt. & R. R., 7% pf.	98	97½	99½
Emerson Elec. pf.	m102½	100	104½
Empire Dist. Elec., 6% pf.	80	80	85
Empire Pwr. A.	k 22	22	32
Eng. Pub. Serv., pf.—no par.	97½	99½	104½
Engr. Pub. Serv., com.—no par.	k 21½	21	29½
Eureka Vac. Cleaner, com.—no par.	k 47	45	53½
FAIRBANKSMORSE, com—no par	49½	46	59½
Fairbanks Morse, pf.	115	108½	115
Federal Lt. & Trac., com.	k 29½	28	39½
Federal Light & Traction, pf.	87	87	89
Federal Utilities, pf.	k 70	....	....
Federal Utilities, com.	k 17	....	....
Ft. Worth Pwr. & Lt., 7% pf.	l105	105	108
GALVESTON-HOUSTON ELEC., 6% pf.	k 37	....	....
Galveston-Hstn El., com.	k 12	....	....
Gen. Elec., w. l.	k 80½	78½	83½
Gen. Elec., com.	k318½	285	386½
Gen. Elec., special—10.	k 11½	11	11½
Gen. G.&E., (Del.) com. A no par.	36½	34	50
Gen. G.&E., (Del.) com. B no par.	k 30	28	45½
Gen. G.&E., (Del.) A pf. $8—no par	107	105½	110½
Gen. G.&E., (Del.) A pf. $7—no par	94½	95½	99½
Gen. G.&E., (Del.) B pf.	94	92½	96
General Public Service, pf.	101	100	106½
General Public Service, com.	m 12½	12½	16½
Ga. Lt., Pwr & Rys., 6% pf.	82	82	85
Ga. Lt., Pwr. & Rys., com.	m 57½	56½	73½
Ga. Ry. & Pwr., 8% pf.	110	112	114
Ga. Ry. & Pwr., 7% pf.	100½	101½	103
Ga. Ry. & Pwr., 4% pf.	m133	....	....
Ga. Ry. & Pwr., com.	k115	....	....
Gt. Western Pwr., 7% pf.	k100	....	....
HAVANA ELEC. UTIL., com.	m 38½	37½	44½
Havana Elec. Util., pf.	69½	64½	71½
IDAHO PWR., 7% pf.	101	103	104
Ill. No. Utilities, 6% pf.	90	88	92
Ill. Pwr. & Lt., 7% pf.	k 97½	....	....
Ingersoll Rand.	k 92½	80½	104
Int. Combus. Engr., com.—no par.	k 44½	33½	64½
Int. Utilities, class A—no par.	k 32	....	....
Int. Utilities, class B—no par.	k 5	4½	9½
Interstate Pwr., pf., $7 no par.	k 93	....	....
Interstate Pub. Serv., 7% pf.	95	96½	97
Iowa Ry. & Lt., 7% pf.	95	98	100
JERSEY CENTRAL PWR. & LT. 7% pf.	95½	95	96½
Jersey Central Pwr. & Lt., pfc. pf.	95½	....	....
Jersey Central Pwr. & Lt., com.—no par.	45	45	50
Johns-Manville, com.—no par.	k138½	130	159½
KANSAS CITY PWR. & LT., pf.	k108½	107½	110½
Kansas Gas & Elec., 7% pf.	l101	99	102
Kentucky Hydro-Elec., pf.	a 94	91½	95
Kentucky Sec., 6% pf.	75	75	77
Kentucky Sec., com.	k100	90	100
Kentucky Utilities, 6% pf.	90	90	95
Keystone Pwr. & Lt. 7% pf.	95	95	97
Kings County Ltg., 7% pf.	101	101	106
Kings County Ltg., 8% pf.	103	105	108
LACLEDE GAS LT., com.	155½	146	168
Lehigh Pwr. Sec., com.—no par.	k 13	10	23
Long Island Ltg., 7% pf.	103½	105	107
Long Island Ltg., com.—no par.	110	120	150
Los Angeles Gas & Elec., 6% pf.	k 96	....	....
Louisville Gas & Elec., Class. A.	k 23½	22½	26½
MANHATTAN ELEC. SUPPLY	k 71½	56	76½
Manila Elec., com.—no par.	32	27½	35
Maytag Mfg., com.	k 20½	19	23½
Memphis Pwr. & Lt., pf., $7, no par	102	103	105
Metro. Edison, pf.—$6—no par.	k 92	....	....
Metropolitan Edison, pf., $7, no par.	102½	102	106
Metropolitan Edison, com., no par.	45	45	50
Middle West Utilities, 7% pf.	a104½	97½	111½
Middle West Utilities, 7% pr. lien pf.	a114½	106½	123½
Middle West Utilities, com.—no par.	a109½	109	134½
Midland Utilities, pr. ln. pf.	a 98½	98	100
Midland Utilities pf. A	m 96	96	98
Milwaukee Elec. Ry. & Lt., 7% pf.	100	....	....
Milwaukee Elec. Ry. & Lt., 6% pf.	91	....	....
Minn. Pwr. & Lt., 7% pf.	l100½	100	103½
Miss. Pwr. & Lt., pf.	k101	....	....
Miss. River Pwr., 6% pf.	93	94	96
Miss. River Pwr., com.	k 60	....	....
Mohawk Hudson Pwr., 1st pf.—$7—no par.	100	101	105
Mohawk Hudson Pwr., 2nd pf.—$7—no par.	k 95	....	....
Mohawk Hudson Pwr., com.—no par	k 22½	20½	28½
Montana Pwr., pf.	m114½	112½	119½
Montana Pwr., com.	k 75½	69½	83½
Montreal Pwr., com.	f220½	....	....
Mountain States Pwr., pf.	k 96	....	....
Mountain States Pwr., com.	k 20	....	....
NASSAU & SUFFOLK. LTG., pf.	93	93	95
National Carbon, pf.	a126	125	128
National Elec. Pwr., pf.	100	98½	100½
National Electric Pwr-A	a 21½	19½	26
Nat.-Lt., Ht. & Pwr., com.—no par.	24	22	25
National Lt., Ht. & Pwr., 5% pf.	72	71	73
National Pwr. & Lt., pf., $7—no par.	k 99½	96	102½
National Pwr. & Lt., com.—no par.	k 19½	16½	38½
National Pub. Serv., 7% pf.	91	90	94
National Pub. Serv., pfc. pf.	95	96	97½
National Pub. Serv., A com.—no par	20½	15½	24
National Pub. Serv., B com.—no par	12½	10	12½
Nebraska Pwr., 7% pf.	l103	103	105½
Nevada-Calif. Elec., com.	m 23	18½	44½
New Brunswick Pwr., pf.	35	30	40
New England Pub. Serv., pr. ln. pf.	98	98	99½
New England Pub. Serv., pf.	88	95½	97
N. J. Pwr. & Lt., 7% pf.	105	104	108
New Orleans Pub. Serv., 7% pf.	99½	100	102
N.Y.& Queens Elec.Lt.& Pwr.,5% pf	88	89	90
N. Y. Central Elec., 7% pf.	m 97	98	100
Newport News & Hampton Ry., Gas & Elec., com.	110	108	112
Newport News & Hampton Ry., Gas & Elec., pf.	110	109	114
Niagara Falls Pwr., 7% pf.—25.	28½	27½	28½
Niagara, Lock. & Ont. Pwr., 7% pf.	108	110	111½
Niagara, Lock. & Ont. Pwr., com.—no par.	m 60½	n 60	n 73
No. Amer., 6% pf.—50.	k 50	49	50½
No Amer., com.—10.	k 47	42	67
No. Amer. Edison pf.—no par.	91	93	95
No. Amer., Lt. & Pwr., pf.	90	88	90
No. American Utilities, pf., full pd.	m 94½	89	96
No. American Utilities, pf., 25% pd.	m 19	18	27
N.C. Pub. Serv., pf.—$7—no par.	k 90	....	....
Northeastern Pwr., com.	k 20	17½	36½
No. Indiana Gas & Elec., pf. A.	m 97	98	100
No. N. Y. Utilities, 7% pf.	k102½	....	....
No. Ohio Pwr., com.—no par.	k 14½	11	26½
No. Ohio Trac. & Lt., 6% pf.	75	78	81
No. Ohio Trac. & Lt., 7% pf.	85	88	91
No. Ont. Lt. & Pwr., pf.	k 75	....	....
No. Ont. Lt. & Pwr., com.	72	45	70
No. States Pwr., 7% pf.	k101	99½	101½
No. States Pwr. com.	k100½	97	136
No. Texas Elec., 6% pf.	k 40	....	....
No. Texas Elec., com.	k 25	....	....
OHIO BRASS, com. B—no par.	74	70	79
Ohio Brass, pf.	100	98	101
Ohio Gas & Elec., 7% pf.	90	92	95
Ohio Pwr., 6% pf.	94	93	95
Ohio Pub. Serv., 6% pf.	90	90	93
Ohio Pub. Serv., 7% pf.	99	98½	100
Ohio River Edison, pf.	99	99½	101½
Oklahoma Gas & Elec., pf.	k 95	....	....
PACIFIC GAS & ELEC., 6% pf.	k 98½	....	....
Pacific Gas & Elec. com.	123½	118	132½
Pacific Pwr. & Lt., 7% pf.	l98½	98	101½
Parr Shoals Pwr., 6% pf.	92	....	....
Penn Central Lt. & Pwr., pf.—no par	c 72½	71	91
Pen-Ohio Edison, 7% pf.	97	95½	97½
Penn-Ohio Elec., 7% pf.	95	93	96

Stock Exchange: aChicago; bSt. Louis; cPhiladelphia; dBoston; eBaltimore; fMontreal; gCincinnati; hSan Francisco; iPittsburgh; jWashington. kBid, low, high, Tuesday, May 4. lBid, low, high, Wednesday, May 5. mLatest quotations available. n1925.

Stock and Bond Quotations of Electric Light and Power and Manufacturing Companies (Continued)

(Prices on New York stock market unless otherwise noted. Unless otherwise noted the par, stated, or preference value of stock is $100.)

Companies	Bid Price Saturday May 1	Low 1926	High 1926
STOCKS—Continued			
Penn-Ohio Pwr. & Lt., 7% pf.	95	94	97
Penn-Ohio Pwr. & Lt., 8% pf.	101	100	106
Penn Pwr. & Lt.—$7—no par.	*l*104½	103	106½
Penn Pub. Serv., 7% pf.	99	96	100
Penn Pub. Serv., 6% pf.	86	85	90
Penn Wtr. & Pwr., com.	*e*146	142	171
Phila. Co., 6% pf.—50.	49½	47¾	50¾
Phila. Co., com.—50.	*k* 73	59¾	76¾
Phila. Elec., com.—25.	*c* 46¼	41¾	67¼
Pittsburgh Utilities, pf.—10.	*k* 19¼	14¼	19¼
Portland Elec. Pwr., 7% pf.	96½	97	98
Portland Elec. Pwr., 6% pf.	75	71	75½
Portland Elec. Pwr., 6% 2d pf.	72	71	75
Portland Elec. Pwr., com.	*k* 37	....	....
Potomac Elec. Pwr., pf.	*j*107½	....	....
Pwr. Corp. of N.Y., com—no par.	*m* 79	77¼	90¾
Pwr. Sec., pf.—no par.	*k* 14	....	....
Pwr. Sec., com.—no par.	*k* 5	....	....
Pub. Serv. of N. J., 7% pf.	106	103¾	108¾
Pub. Serv. of N. J., 8% pf.	120	115	120
Pub. Serv. of N. J., com.—no par.	*k* 79	72	92¼
Pub. Serv. of No. Ill., 6% pf.	*a*101½	100¼	103
Public Serv. of No. Ill., 7% pf.	*a*115½	112	116¾
Pub. Serv. of No. Ill., com.—no par	*a*129	128¼	137
Pub. Serv. of No. Ill., com.	*a*129	128¼	131¼
Pub. Serv. of Okla., 7% pf.	95	92	95
Pub. Serv. Elec. & Gas, 6% pf.	*k*100½	97	99¼
Public Service Elec. Pwr., pf.	110½	106	110
Puget Sound Pwr. & Lt., 7% pf.	*k*106	....	....
Puget Sound Pwr. & Lt., 6% pf.	*k* 83	....	....
Puget Sound Pwr. & Lt., com.	*k* 49	....	....
RADIO CORP. OF AM., pf.—50.	46¾	44¼	47¼
Radio Corp. of Amer., com.—no par.	*k* 38¼	32	46¾
Republic Ry. & Lt., pf.	*k*104	....	....
Republic Ry. & Lt., com.	*k* 84	....	....
Rochester Gas & Elec., 5% pf.	*m* 95	80	98
Rochester Gas & Elec., 6% pf.	101	100	102
Rochester Gas & Elec., 7% pf.	104	105	107
SAN JOAQUIN LT. & PWR., 7% pf	97	97½	98¼
St. Joseph Ry., Lt., Ht. & Pwr., pf.	65	60	65
Servel Corp., Class A	*k* 22	15½	30½
Servel Corp., Class B—no par.	*k* 44	....	....
Sierra Pacific Elec., com.	*k* 25½	23	28¼
Sioux City Gas & Elec., 7% pf.	97	96	98
S. E. Pwr. & Lt., pf.—$7—no par.	97	97	100
Southeastern Pwr. & Lt., pr. pf.	*k* 64	59	65¼
S. E. Pwr. & Lt., com.—no par.	*k* 27½	21¼	46¾
So. Calif. Edison, 8% pf.	130	135	140
So. Calif. Edison, 7% pf.	*k*109	....	....
So. Calif. Edison, 6% pf.	*k* 97	....	....
So. Calif. Edison, com.	*k*118	115	148
Southern Cities Utilities, 7% pf.	*k* 85	....	....
Southern Cities Utilities, com.	*k* 31	....	....
Southwestern Lt. & Pwr., A	*k* 55	....	....
Southwestern Lt. & Pwr., B	*k* 45	....	....
Southwestern Lt. & Pwr., $6 pf.	*k* 81	....	....
Southwestern Pwr. & Lt., 7% pf.	*k* 98	....	....
Springfield (Mo.) Ry. & Lt., 7% pf.	95	....	....
Standard Gas & Elec., 8% pf.	*k* 55½	53¾	57¼
Standard Gas & Elec., 7% pf.	*k*100¼	....	....
Standard Gas & Elec., com —no par.	*k* 53¼	51	69
Standard Pwr. & Lt., 7% pf.	*k* 92	....	....
Staten Island Edison, pf.—$6—no par	92½	93	95
Superheater, com.—no par.	*k*138	....	....
Syracuse Lighting, 7% pf.	102	105	107
Syracuse Lighting, 8% pf.	118	....	....
Syracuse Lighting, com.	290	260	315
TAMPA ELEC., com.	*k*280	....	....
Tampa Elec., com., new	*k* 58	55¾	58
Tenn. Elec. Pwr., 6% pf.	*k* 85	....	....
Tenn. Elec. Pwr., 7% pf.	*k* 99	....	....
Terre Haute, Ind. & East Trac., pf.	20	23	37
Terre Haute, Ind. & East. Trac., com	3	3	5
Tex. Pwr. & Lt., 7% pf.	*l*104	102	105
Tide Water Pwr., 8% pf.	*k*101	....	....
Timken Roller Bearing, com—no par	*k* 50	44¼	56¼
Toledo Edison, 8% pf.	111	112	114
Toledo Edison, 7% pf.	101½	101	103
Toledo Edison, com.	100	....	....
Tri-City Ry. & Lt., 6% pf.	89	87½	89
UNITED GAS & ELEC., 6% pf..	94	94	97
United Gas & Elec., com.—no par..	*m*57	56	66
United Gas & Elec. (N.J.), 5% pf....	68	70	75
United Gas Impr.—50.	*c* 99¼	84¼	144½
United Lt. & Pwr., pf.—$4—no par.	44	....	51
United L. & P. pf.—$6.50—no par...	85	81	91
United Lt. & Pwr., com. A.—no par, new	14	12¼	28
United Lt. & Pwr., com., B—no par	60	140	165
Utah Pwr. & Lt., 7% pf.	*l*101½	99	103¼
Utica Gas & Elec., 7% pf.	104	103	105
Utica Gas & Elec., com.	200	....	....
Utilities Pwr., & Lt., 7% pf.	*k* 94	....	....
Utilities Pwr. & Lt., com A	*k* 31	28½	37
Utilities Pwr. & Lt., com. B—no par.	15	14	18
VERMONT HYDRO - ELEC., 7% pf.	94	95	96
Virginian Pwr., 7% pf.	102	101	103½
Virginian Pwr., com.	68	....	....
Virginia Elec. & Pwr., 7% pf.	102	101	103½
Virginia Ry. & Pwr., com.	*m*150	150	150
WAGNER ELEC., pf.	*b* 74	70	85
Wagner Elec., com.—no par.	*b* 22½	20	34½
Washington Ry. & Elec., com.	*j*180½	....	....
Washington Ry. & Elec., pf.	*j* 91	....	....
Washington Wtr. Pwr., com.	123	130	134
West Mo. Pwr., 7% pf.	*k* 91	....	....
West Penn., 7% pf. temp. ctfs.	*m* 99	95½	101
West Penn. com.	*m*125	118	130
West Penn Elec., pf.	97½	96¼	100½
West Penn Elec., Class A.	92	88¼	97
West Penn Pwr., pf.	109	108	108
West Va. Lt., Ht. & Pwr., 7% pf..	95	95	98
West Va. Utilities, 7% pf.—50.	43	43	45
Western Pwr., 7% pf.	*k* 93	91½	99
Western Pwr., com.—no par.	*m* 80	*n* 34	*n*102
Western States Gas & Elec., 7% pf.	*k* 90	....	....
Western States Gas & Elec., com.	*k* 17	....	....
Westinghouse El. & Mfg., com—50.	*k* 67½	65¾	79½
Weston Elec. Instrument, Class. A..	30	27½	31½
Weston Elec. Instrument, com.	16	13¾	19
Wheeling Elec., pf.	90	91	93½
Wis. Pwr., Lt. & Ht., 7% pf.	90	85	90
Worthington Pump, pf. A.	75½	73	80
Worthington Pump, pf. B.	56	53	65
Worthingington Pump, com.	*k* 23½	20½	44½
YADKIN RIVER PWR., 7% pf	*l*104½	102	105
Yale & Towne, com.—25.	*k* 64	60½	64½
BONDS			
ABITIBI PWR. & PAPER.	6s	1940	*k*101½	....	....
Adir. Elec. Pwr.	5s	1962	*k*101	....	....
Adir. Pwr. & Lt.	6s	1950	*k*105½	....	....
Adir. Pwr. & Lt.	5s	1930	97½	97	99
Ala. Pwr.	5s	1946	100	99	100½
Ala. Pwr.	5s	1951	98	97	99½
Ala. Pwr.	6s	1951	104½	104½	105½
Ala. Trac., Lt. & Pwr.	5s	1962	*m*111	112	124
Aluminum Co. of Amer.	7s	1933	106½	106½	107½
Amer. Bosch Magneto.	8s	1936	*m*103	2½	....
Amer. Gas & Elec.	5s	2007	93	92	93½
Amer. Gas & Elec.	6s	2014	99½	98	100
Amer. Pwr. & Lt.	6s	2016	*k* 98½	96	98
Amer. Pub. Serv.	6s	1942	100½	98½	100½
Amer. Wtr. Wks. & Elec.	5s	1934	*k* 97½	....	....
Amer. Wtr. Wks. & Elec.	6s	1975	*k* 94½	92½	94½
Anaconda Copper.	6s	1929	102½	102½	103¾
Anaconda Copper.	6s	1953	*k*103¾	....	....
Anaconda Copper.	7s	1938	*k*105½	....	....
Appalachian Pwr.	5s	1941	*k*100	....	....
Appalachian Pwr.	6s	2024	94	93½	95
Appalachian Pwr.	7s	1936	107	105	107½
Arizona Pwr.	6s	1933	100½	99½	101
Arizona Pwr.	6s	1947	96	95½	97
Ark. Central Pwr.	6s	1948	103	102	103½
Ark. Lt. & Pwr.	6s	1945	*k*104¼	....	....
Ark. Lt. & Pwr.	6s	1954	*k*100½	99	101½
Assoc. Gas & Elec.	6s	1965	*k* 93½	92½	94½
Assoc. Gas & Elec.	6½s	1954	*k*101	....	....
BERLIN CITY ELEC.	6½s	1928	99½	98	99½
Berlin City Elec.	6½s	1929	98½	97	98¾
Binghamton Lt., Ht. & Pwr.	5s	1946	*k* 99	....	....
Birmingham Elec.	6s	1954	103½	102½	104
Birmingham Ry., L. & P.	4½s	1954	90	91	92
Broad River Power.	5s	1954	90	91	92
Broad River Pwr.	6½s	1934	100	100	102
Brooklyn Edison.	5s	1949	*k*103½	....	....
Brooklyn Edison.	6s	1930	104½	103½	106½
Buffalo Gen. Elec. 1st.	5s	1939	102	101½	102½
Buffalo G. E., 1st & Ref.	5s	1939	101½	101½	102½
Buffalo G. E.	5s	1956	102½	99½	102½
Burlington Ry. & Lt.	5s	1932	96½	96	97½
Butte Elec. & Pwr.	5s	1951	*k*100½	....	....
CALIF. ELEC. GEN.	5s	1948	*k*100½	....	....
Calif. Gas & Elec.	5s	1937	101½	100½	101½
Calumet Gas & Elec.	5½s	1960	99½	97½	99
Canadian Lt. & Pwr.	5s	1949	57	56	64
Canton Elec.	5s	1937	100	100	101
Carolina Pwr. & Lt.	5s	1938	101	100½	102½
Carolina Pwr. & Lt.	5s	1956	*k* 98½	97½	99½
Carolina Pwr. & Lt.	6s	1953	*m*104½	104½	105½
Cedar Rap. Mfg. & Pwr.	5s	1953	100½	99½	101½
Central Ark. Ry. & Lt.	5s	1928	99½	99	100½
Central Ga. Pwr.	5s	1938	96	95	96½
Central Ill. Lt.	5s	1943	*k*100½	....	....
Central Ill. Pub. Serv.	5s	1952	93½	92	93½
Central Ill. Pub. Serv.	5½s	1950	97½	96	97½
Central Ill. Pub. Serv.	6s	1944	100½	99	101½
Central Ind. Pwr.	6s	1947	99	98	99½
Central Ia. Pwr. & Lt.	6s	1944	100	99½	101
Central Maine Power.	5s	1939	99½	98½	100
Central N. Y. Gas & El.	5s	1941	*k* 98	....	....
Central Pwr. & Lt.	6s	1946	*m*101½	....	....
Central Pwr. & Lt.	6½s	1952	*k*105½	....	....
Central States Elec.	6s	1945	*k* 92½	....	....
Chattanooga Ry. & Lt.	5s	1956	89	81	90
Cincinnati Gas & Elec.	5s	1956	102½	102	103½
Cincinnati Gas & Elec.	5½s	1961	104½	102½	105
Cities Service.	6s	1966	*k* 92	91½	93½
Cities Service.	7sB	1966	*k*186	....	....
Cities Service.	7sC	1966	*k*129	125½	131
Cities Service.	7sD	1966	*k*103½	101½	104
Cities Service.	7sE	1966	*k*109	....	....
Cities Service Pwr. & Lt.	6s	1944	*k* 96	96	96
City L. & T., Sedalia, Mo	5s	1952	85½	83	85½
Cleveland Elec. Illum.	5s	1939	103	102½	103½
Cleveland Elec. Illum.	5s	1954	*k*103	....	....
Cleveland Elec. Illum.	7s	1941	111	110	112
Colorado Pwr.	5s	1953	98½	95½	98
Columbia Gas & Elec.	5s	1927	*k*100½	....	....
Columbia Ry., Gas & El.	5s	1936	93	92½	95¾
Columbus, Dela. & Marion Elec.	5s	1937	86	83½	86
Columbus, Dela. & Marion Elec.	6s	1937	94½	93½	96
Columbus Elec. & Pwr.	6s	1947	*k*103	....	....
Columbus Ry., Pwr. & Lt.	5s	1940	*k* 98	....	....
Columbus Ry., Pwr. & Lt.	6s	1941	*k*104	....	....
Commonwealth Edison.	5s	1943	*k*102½	....	....
Commonwealth Edison.	5s	1953	101½	99½	101½
Commonwealth Edison.	5s	1954	*k*101	....	....
Commonwealth Pwr.	5s	1939	*k* 92½	....	....
Commonwealth Pwr.	6s	1972	*k* 97	....	....
Commonwealth Pwr.	6s	1947	*k*104½	....	....
Community Pwr. & Lt.	6s	1950	100	98	100½
Conn. Ry. & Ltg.	4½s	1951	87½	90½	92
Consol. Cities Lt., Pwr. & Trac.	5s	1962	80	80	82½
Consol. Elec.	5s	1955	97½	98	99
Consol. Gas of N. Y.	5½s	1945	*k*106	....	....
Con. Gas. Elec. Lt. & Pwr. of Balti.	4½s	1935	*e* 98½	95½	98½
Con. Gas. Elec. Lt. & Pwr. of Balti. (notes)	6s	1949	107	105½	107½
Con. Gas. Elec. Lt. & Pwr. of Balti.	5s	1965	*m*101½	100	101½
Con. Gas. Elec. Lt. & Pwr. of Balti. (notes)	5½s	1952	*e*105½	104½	105½
Con. Gas. Elec. Lt. & Pwr. of Balti. (notes)	6½s	1951	*m*109½	109	109½
Consumers Elec. L. & P.	5s	1936	*k* 97½	....	....
Consumers Pwr.	5s	1936	*k*101	....	....
Consumers Pwr.	5s	1952	*k*100½	....	....
Consumers Pwr.	5½s	1954	*k*104½	....	....
Continental Gas & Elec.	5s	1927	*k*100	....	....
Continental Gas & Elec.	6s	1947	*k*101½	....	....
Continental Gas & Elec.	6½s	1964	*k* 99½	....	....
Continental Gas & Elec.	7s	1954	*k*105½	....	....
Cumberland Cty. Pw. & Lt.	5s	1942	97	94	97½
DALLAS PWR. & LT.	6s	1949	104½	104	105
Dayton Ltg.	5s	1937	100	100	101
Dayton Pwr. & Lt.	5s	1941	*k* 101	....	....
Defiance Gas & Elec.	5s	1942	98½	98	99
Denver Gas & Elec.	5s	1949	99	98	100
Denver Gas & Elec. Lt.	5s	1951	*k* 96½	....	....
Des Moines Elec.	5s	1938	101	99	101
Detroit Edison.	5s	1933	102	101	102½
Detroit Edison.	5s	1940	102	100½	102½
Detroit Edison.	5s	1949	101½	100	102½
Detroit Edison.	5s	1955	*m*101	100½	101½
Detroit Edison.	6s	1932	*m*124½	124½	135
Detroit Edison.	6s	1940	*k*102	....	....
Detroit Edison.	7s	1928	*m*131½	124½	134
Detroit Edison.	7s	1929	*m*131	124½	131
Detroit Edison.	7s	1930	*m*131	124½	138½
Dominion Pwr. & Trans.	5s	1932	96½	95	97
Driver-Harris.	8s	1931	97½	95	98½
Dubuque Elec.	6s	1942	102½	102	103½
Duke-Price Pwr.	6s	1949	107	102	106
Duke Price Pwr.	6s	1966	*k*101½	100½	101½
Duquesne Lt.	6s	1949	106	105½	107
Duquesne Lt.	5½s	1949	105½	105	106½
Durham Pub. Serv.	7s	1949	100½	99	101½
EAST PENN. ELEC.	6s	1953	104½	105	106
East. N. J. Pwr.	6s	1949	101	99	101½
East Oregon Lt. & Pwr.	6s	1929	100	100	101
East. Tex. Elec.	5s	1942	*k* 97	....	....
Economy Lt. & Pwr.	5s	1956	98½	99	100
Edison Elec. Illum. of Boston (notes)	4½s	1928	99½	99½	100½
Edison Elec. Illum. of Bklyn.	4s	1939	94¾	93	99¼
Edison El. Illum. (N.Y.).	5s	1995	105½	103	105
El Paso Elec.	5s	1932	*m*102	....	....
El Paso Elec.	5s	1950	97½	95	97½
El. Pwr. Corp. (Germany)	6½s	1950	88½	....	....
Elec. Refrigeration.	6s	1936	*k*104½	100½	107
Elmira Wtr., Lt. & R.R.	5s	1956	97	96	97½
Empire Dist. Elec.	5s	1949	93½	92	94½
Erie Ltg.	5s	1967	99½	99	100½
Evansville G. & El. Lt.	5s	1932	99	99	100
FEDERAL LT. & TRAC.	5s	1942	95½	92½	97½
Federal Lt. & Trac.	6s	1942	102½	100	104½
Federal Lt. & Trac.	6s	1954	94	93	96
Florida Power & Light.	5s	1954	*k* 94	91½	94½
Florida Publ. Service.	6s	1955	97	97	99
Florida Public Service.	6½s	1949	99½	99	103
Ft. Smith Lt. & Trac.	5s	1936	*k* 77	....	....
Ft. Worth Pwr. & Lt.	5s	1931	100½	99	100½
GALVESTON ELEC.	5s	1940	88	89	92
General Elec.	3½s	1942	90	87	89½
Georgia Carolina Pwr.	5s	1952	90½	87	91
Ga. Lt., Pwr. & Rys.	5s	1941	88½	88	92
Ga. Ry. & Elec.	5s	1932	99½	98½	100½
Ga. Ry. & Elec.	5s	1949	95½	94½	97
Ga. Ry. & Pwr.	5s	1954	98	96	99
Ga. Ry. & Pwr.	6s	1947	*k*104	....	....
Ga. Ry. & Pwr.	7s	1941	*k*105	....	....
German Gen. Elec.	6½s	1940	*k* 97½	94	99½
German Gen. Elec.	7s	1945	98	95	98½
Great Cons. Elec. Pwr. (Japan)	6½	1950	*k* 85½	85	86
Great Cons. Elec. Pwr. (Japan)	7s	1944	*k* 92½	....	....
Great Falls Pwr.	5s	1940	104	101½	104½
Great Northern Pwr.	5s	1935	99½	98½	100½
Great Western Pwr.	5s	1946	*k* 99½	....	....
Great Western Pwr.	5½s	1955	100	99	101
Great Western Pwr.	6s	1949	102½	102	103½
Great Western Pwr.	6s	1952	*k*103	....	....
HAMBURG ELEC.	7s	1935	*k* 96½	94	97½
Havana Elec. R., Lt. & P	5s	1954	95	92½	95
Holtwood Pwr.	6s	1954	104½	100	104½
Houston Ltg. & Pwr.	5s	1931	100	99	101
Houston Ltg. & Pwr.	5s	1953	96½	90½	95½
Houston Ltg. & Pwr.	5½s	1954	100½	99½	102½
Hydraulic Pwr.	5s	1951	101½	101½	102
Hydraulic Pwr.	5s	1950	101½	101½	103
IDAHO PWR.	5s	1947	98½	96	98½
Ill. Elec. Pwr.	6s	1943	103½	102	103½
Ill. Pwr.	5s	1933	*k* 95½	....	....
Ill. Pwr.	6s	1944	*k* 99	....	....
Ill. Pwr. & Lt.	5½s	1954	98½	97½	99
Ill. Pwr. & Lt.	6s	1953	102	100½	102½
Ill. Pwr. & Lt.	7s	1953	102	102	103¾
Ind. Elec.	6s	1947	99	98	100
Ind. Gen. Serv.	5s	1948	98½	96½	98½
Ind. Lighting.	4s	1958	83½	82½	84
Indiana & Mich. Elec.	5s	1955	98½	96	98½
Indiana & Mich. Elec.	5s	1957	100	97½	100½
Ind. Service.	5s	1950	92½	91½	93
Ind. Service.	6s	2020	86	83	88½
Ingersoll-Rand.	5s	1935	100	....	....
International Pwr. Sec.	6½s	1955	*l* 91	....	....
Interstate Elec.	6s	1933	96½	94	98½
Interstate Pwr.	6s	1944	*k* 99	....	....
Interstate Pwr.	7s	1934	*k* 99½	....	....
Interstate Pub. Serv.	6s	1948	99½	98	99½
Iowa Ry. & Lt.	5s	1932	98½	97½	99½
Iowa Southern Utilities.	5½s	1950	94	94	96
Inter. Pwr. Sec.	6½s	1955	*j*90½	....	....
JERSEY CENT. PWR. & LT.	5½s	1945	96½	95	98
KANSAS CITY PWR. & LT.	5s	1952	*k*102½	....	....
Kansas Elec. Pwr.	6s	1937	*k*101½	....	....
Kansas Elec. Pwr.	6s	1943	101½	99½	102½
Kansas Gas & Elec.	6s	1952	104½	101½	105½
Kansas Gas & Elec.	6s	2022	93¾	92½	93¾

Stock Exchange: *c*Chicago; *b*St. Louis; *c*Philadelphia; *d*Boston; *e*Baltimore; *f*Montreal; *g*Cincinnati; *h*San Francisco; *i*Pittsburgh; *j*Washington. *k*Bid, low, high, Tuesday, May 4. *l*Bid, low, high, Wednesday, May 5. *m*Latest quotations available. *n*1925.

Stock and Bond Quotations of Electric Light and Power and Manufacturing Companies (Continued)

(Prices on New York stock market unless otherwise noted. Unless otherwise noted the par, stated, or preference value of stock is $100.)

Companies			Bid Price Saturday May 1	Low 1926	High 1926
BONDS (Continued)					
Kentucky Hydro Elec....	6s	1949	100½	99½	101½
Kentucky Utilities.....	6s	1949	101½	99½	101½
Kings Cty. Elec. L. & P..	5s	1937	102½	102	103½
Kings Cty. Elec. L. & P..	6s	1997	123½	120½	123½
Kings County Ltg.....	5s	1954	100	98½	100½
Kings County Ltg.....	6½s	1954	109	106	110
Knoxville Ry. & Lt.....	5s	1946	97½	95½	98
LACLEDE GAS LT....	5s	1934	100½	100½	101½
Laclede Gas Lt.....	5½s	1953	k100	98	100½
Laurentian Pwr.....	6s	1936	100½	100	101
Laurentide Pwr.....	5s	1946	100	100	102
Lehigh Pwr. Sec.....	6s	2026	k 95½	93	95½
Lincoln Gas & Elec.....	5s	1941	94	92½	94½
Long Island Ltg.....	5s	1936	k100	....	....
Long Island Ltg.....	6s	1954	101½	99½	102
Long Island Ltg.....	6s	1948	107	104½	106
Los Angeles Gas & Elec..	5s	1939	k100½	....	....
Los Angeles Gas & Elec..	5½s	1943	101½	99	102
Los Angeles Gas & Elec..	5½s	1947	k102	....	....
Los Angeles Gas & Elec..	5½s	1949	101½	99	102
Los Angeles Gas & Elec..	6s	1942	105	102½	105½
Louisiana Pwr.....	6s	1944	99½	98½	100
Louisville Gas & Electric..	6s	1937	101	100	102
Louisville Gas & Elec....	5s	1952	k 99½	....	....
Louisville Gas & Elec....	5½s	1954	104	102	104½
Lower Austrian Hydro El.	6½s	1944	83½	83½	87½
Luzerne Cty. Gas & El...	5s	1948	99½	97½	99½
Luzerne Cty. Gas & El...	7s	1944	105	103½	105½
Luzerne Cty. Gas & El...	6s	1954	103½	102	104
MADISON RIV. PWR..	5s	1935	100½	100	101
Manila Elec.....	7s	1942	115	102	115½
Manila Elec. Ry. & Ltg..	5s	1953	91½	89½	94
Manitoba Pwr.....	5½s	1951	k 97	94½	98
Memphis Pwr. & Lt.....	5s	1948	99½	99	100½
Metropolitan Edison.....	6s	1952	108	104	108
Metropolitan Edison.....	5s	1953	100	96½	101½
Metropolitan Pwr.....	6s	1953	104	102½	104½
Michigan Lt.....	5s	1946	k 99½	....	....
Michigan No. Pwr.....	5s	1941	99½	97	100
Milwaukee El. Ry. & Lt..	4½s	1931	99	97	99
Milwaukee El. Ry. & Lt..	5s	1951	99½	98½	100
Milwaukee El. Ry. & Lt..	5s	1961	k 95½	....	....
Milwaukee El. Ry. & Lt..	6s	1953	104½	100½	104½
Minn. Pwr. & Lt.....	5s	1955	97½	95½	97
Minn. Pwr. & Lt.....	6s	1950	105½	104	106
Miss. Power.....	5s	1955	93	92	94
Miss. River Pwr.....	5s	1951	99½	99	100½
Miss River Pwr.....	7s	1935	101½	102	103
Mo. Edison Elec.....	5s	1927	m100½	100½	100½
Mo. Pwr. & Lt.....	5½s	1955	97½	96	98½
Mobile Elec.....	5s	1946	k 98½	....	....
Monongahela W. Pa. Pub. Service.....	5½s	1953	96	95	97½
Montana Pwr.....	5s	1943	k101½	....	....
Montreal Lt., Ht. & Pwr.	4½s	1932	97½	97	98½
Montreal Lt., Ht. & Pwr.	5s	1933	99½	99½	101
Montreal Pub. Serv.....	5s	1942	94½	94	95½
Mountain States Pwr.....	6s	1938	100	98½	101
Municipal Service.....	5s	1942	93	92½	93½
NASHVILLE RY. & LT.	5s	1953	98½	96½	98½
Nashville Ry. & Lt.....	5s	1958	92½	90½	92½
Nassau Lt. & Pwr.....	5s	1927	99½	98½	100½
Nassau & Suffolk Ltg....	5s	1945	92½	89½	93
National Elec. Power.....	6s	1945	92½	92½	94
National Pwr. & Lt.....	7s	1972	k104	....	....
National Pub. Serv.....	6½s	1955	94½	94½	97
Nebraska Pwr.....	5s	1949	100½	99	101½
Nebraska Pwr.....	6s	2022	97½	94½	98
Nevada-Calif. Elec.....	6s	1946	k101½	....	....
Nevada-Calif. Elec.....	6s	1950	100	98½	101
New Brunswick Pwr.....	5s	1937	83½	81½	85
New England Pwr.....	5s	1951	103½	100½	104½
New Jersey Pwr. & Lt....	5s	1936	99	96½	99
New Orleans Pub. Serv..	4½s	1935	89½	87	89½
New Orleans Pub.Serv.,B.	5s	1952	k 95½	....	....
New Orleans Pub. Serv...	5s	1955	96	90½	96½
New Orleans Pub. Serv...	6s	1949	91½	90	92½
N.Y. & Queens El. L.&P..	5s	1930	102½	100½	103½
N.Y. & Westchester Ltg..	4s	2004	80	79½	81½
N.Y. & Westchester Ltg..	5s	1954	98	97½	98½
New York Edison.....	6½s	1941	k116½	....	....
New York Edison.....	5s	1944	k103½	....	....
N.Y. Gas & El. L., H.&P.	5s	1948	105	104	105
N.Y. Gas & El. L., H.&P.	4s	1949	90½	89½	91½
N.Y. State Gas & Elec...	5½s	1962	101	100	101
Newport News & Hampton Ry., Gas & Elec....	5s	1944	90	89½	91
Niagara Falls Pwr.....	5s	1932	102½	100½	103
Niagara Falls Pwr.....	6s	1932	106	104½	106½
Niagara Falls Pwr.....	6s	1950	106½	105	107
Niagara, Lock. & Ont. Pwr.	5s	1955	k101	....	....
Niagara, Lock. & Ont. Pwr.	6s	1958	m106	....	....
Norfolk Ry. & Lt.....	5s	1949	95½	94	96½
No. Amer. Edison.....	6s	1952	k104½	....	....
No. Amer. Edison.....	6½s	1948	105½	103½	106
No. Amer. Lt. & Pwr.....	7s	1954	99	99	100½
North Caro. Pub. Serv...	5s	1934	k 94	....	....
North Caro. Pub. Serv...	6s	1954	95½	94½	97
North Caro. Pub. Serv...	6½s	1944	99	98	100½
North Shore Elec.....	5s	1940	100½	98½	100½
No. Calif. Pwr.....	5s	1948	100½	99½	101½
No. Ind. Gas & Elec.....	5s	1929	99½	99	100
No. Ind. Gas & Elec.....	6s	1952	104½	102½	105
Northern N. Y. Utilities..	5s	1955	97½	95	97
Northern N. Y. Utilities..	5½s	1949	100½	100	101½
No. Ohio Pwr.....	7s	1935	k 93½	....	90½
No. Ohio Trac. & Lt.....	4s	1933	90	87	90½
No. Ohio Trac. & Lt.....	5s	1956	84½	84	86
No. Ohio Trac. & Lt.....	6s	1926	99½	99	100
No. Ohio Trac. & Lt.....	6s	1947	95½	92½	96½
No. States Pwr.....	6½s	1933	k112	108	132
No. States Pwr. (notes)....	6½s	1933	k103½	102½	104
No. States Pwr.....	6s	1948	k103½	....	....
No. States Pwr.....	6s	1941	106	105½	106½
No. States Pwr.....	5s	1941	k 99½	....	....
No. Tex. Elec.....	5s	1940	70	72	75
Northwestern Elec.....	6s	1935	102½	102	103½
Northwestern Pub. Serv..	6½s	1948	101½	99½	101½
Nova Scotia Tr. & Pwr...	5s	1946	88	88	90
OHIO PWR.....	5s	1952	97½	94	97½
Ohio Pwr.....	6s	1953	104½	103½	104½
Ohio Pwr.....	6s	2024	97½	95½	98
Ohio Pwr.....	7s	1951	106	105½	106½
Ohio Pub. Serv.....	5s	1954	95½	92½	94½
Ohio Pub-Serv.....	6s	1953	101½	101	102½
Ohio Pub. Serv.....	7½s	1946	113½	112½	113½
Ohio Pub. Serv...	7s	1947	112	110½	112
Ohio River Edison.....	6s	1948	103½	101½	104½
Okla. Gas & Elec.....	5s	1950	94½	93	94½
Okla. Gas & Elec.....	6s	1940	k 96	....	....
Ontario Pwr. of Niagara Falls.....	5s	1943	k101½	....	....
Ontario Transmission....	5s	1945	99½	99½	99½
Osark Pwr. & Wtr.....	5s	1952	80½	77	81½
PACIFIC COAST PWR..	5s	1940	99½	99	100½
Pacific Gas & Elec.....	5s	1942	k 99½	....	....
Pacific Gas & Elec.....	5½s	1952	k104	....	....
Pacific Gas & Elec.....	6s	1941	k108	....	....
Pacific Lt. & Pwr.....	5s	1942	k101½	....	....
Pacific Lt. & Pwr.....	5s	1951	100½	100	101½
Pacific Pwr. & Lt.....	5s	1930	100	99½	101
Pacific Pwr. & Lt.....	5s	1953	m 96½	....	....
Parr Shoals Pwr.....	5s	1952	97	95	98½
Paterson & Passaic G.&E.	5s	1949	102	100	101½
Penn Central Lt. & Pwr..	5½s	1975	95½	94½	97
Penn Central Lt. & Pwr...	6s	1953	103½	102½	105
Penn Edison.....	5s	1946	98½	96½	98½
Penn. Elec.....	6s	1955	m105	92	105
Penn Elec.....	6½s	1954	m105	97	100½
Penn.-Ohio Edison.....	6s	1950	101½	98	106
Penn Ohio Elec.....	6½s	1938	105½	105	107
Penn Ohio Pwr. & Lt.....	5½s	1954	k100½	....	99½
Penn Ohio Pwr. & Lt.....	6s	1939	98	97	98½
Penn Pwr. & Lt.....	5s	1952	99½	97½	99½
Penn Pwr. & Lt.....	5s	1953	99½	97½	99½
Penn Pwr. & Lt.....	6s	1953	105½	105	106
Penn Pwr. & Lt.....	7s	1951	106	105½	106½
Penn Pub. Serv.....	5s	1954	97½	96	98½
Penn Pub. Serv.....	6s	1947	104½	103	105
Penn Wtr. & Pwr.....	5s	1940	101½	101½	102½
Penn Wtr. & Pwr.....	5½s	1953	103½	102½	103½
Phila. Co.....	6s	1944	k105	....	....
Phila. Co.....	5½s	1938	k100½	....	....
Phila. Co.....	5s	1951	98	97½	99½
Phila. Co.....	5s	1949	m104½	103½	104½
Phila. Elec.....	5s	1966	c103½	102	104½
Phila. Elec.....	4s	1966	c 87	84	87½
Phila. Elec.....	5s	1960	c102½	102	103½
Phila. Elec.....	6s	1941	107½	106	108
Phila. Elec.....	5½s	1947	c107½	103½	107½
Phila. Elec.....	5½s	1953	c107½	103½	107½
Phila. Elec. Pwr.....	5½s	1972	k102	100½	102½
Portland Elec. Pwr.....	6s	1947	102	99	102½
Portland Gen. Elec.....	5s	1935	101½	99½	102
Portland Ry., Lt. & Pwr..	5s	1942	92½	88½	93
Portland Ry., Lt. & Pwr..	6s	1947	k100½	....	....
Portland Ry., Lt. & Pwr..	7½s	1946	107	106½	108½
Potomac Edison.....	6s	1949	100	99	100½
Potomac Edison.....	6½s	1948	103½	103	104
Potomac Elec. Pwr.....	5s	1929	j100½	....	....
Potomac Elec. Pwr.....	5s	1936	j100½	....	....
Potomac Elec. Pwr.....	6s	1953	j106½	....	....
Potomac Elec. Pwr.....	7s	1941	j106½	....	....
Power Corp. of N. Y.....	6s	1942	100½	101	101½
Power Corp. of N. Y.....	6½s	1942	101½	104	105½
Power Securities.....	6s	1949	k 76	....	....
Pub. Lt. & Pwr.....	5s	1945	68	68	73
Pub. Serv. Co. of Colo....	5½s	1954	95½	95	96½
Pub. Serv. Co. of Colo....	6s	1953	100½	100	101½
Pub. Serv. Co. of Colo....	7s	1933	101	101½	102½
Pub. Serv. Corp. of N.J..	5s	1959	m101	104½	105
Pub. Serv. Corp. of N.J..	6s	1944	k103½	....	....
Pub. Serv. Co. of No. Ill..	5s	1956	99	98	99½
Pub. Serv. Co. of No. Ill..	5½s	1962	103½	103½	105
Pub. Serv. Co. of No. Ill..	5½s	1964	103½	103½	105½
Pub. Serv. Co. of Okla....	6s	1949	101½	98½	102
Pub. Serv. Elec. & Gas...	5½s	1959	105½	103½	105½
Pub. Serv. Elec. & Gas ...	5½s	1964	k105	....	....
Pub. Util. Evansville, (Ind.)	6s	1937	k100	....	....
Puget Sound Pwr.....	5s	1933	100½	99	101½
Puget Sound Pwr. & Lt...	5½s	1949	k101	....	....
QUEBEC PWR.....	6s	1953	103½	101½	104
Queensborough Gas & E..	5s	1952	100	99½	100½
Queensborough Gas & E..	6s	1953	105	104	105½
Quincy (Ill.) Gas, Elec. and Heat.....	5s	1935	94	93	94½
RHINE-WESTPHALIA ELECTRIC PWR.....	7s	1950	k 96	93½	96
Rio de Janeiro Tram., Lt. & Pwr.....	5s	1935	94	93	94½
Robbins & Myers.....	7s	1952	63	58	68
Rochester Gas & Elec.....	5½s	1948	105	105½	106
Rochester Gas & Elec.....	7s	1946	k112	....	....
Rochester Ry. & Lt.....	5s	1954	101	100½	101½
Rockford Elec.....	5s	1939	100½	99½	100½
Rome Wire.....	6s	1940	98½	98	100½
ST. MAURICE PWR...	6½s	1953	108½	108	109½
St. Paul Gas Lt.....	5s	1944	101	100½	101½
St. Paul Gas Lt.....	5½s	1954	101½	101	102½
St. Joseph Ry., Lt., H.&P.	5s	1937	95½	91½	97
Salt River Valley Wtr....	6s	1938	k100	....	....
Salmon River Pwr.....	5s	1952	100½	100½	101½
San Antonio Gas & Elec..	5s	1949	96½	96	97½
San Antonio Pub. Serv...	6s	1952	104	101½	104
San Diego Cons. G.&E....	5s	1939	k100½	....	....
San Diego Cons.G.&E....	6s	1939	102½	101	102½
San Joaquin Lt. & Pwr...	5s	1945	100	98½	100
San Joaquin Lt. & Pwr...	6s	1950	103½	103	104½
San Joaquin Lt. & Pwr...	6s	1952	104	99½	104
San Joaquin Lt. & Pwr...	6s	1954	103	100½	102½
Sauda Falls.....	5s	1955	96	94	96
Savannah Elec. & Pwr....	7½s	1941	k101½	....	....
Saxon Pub. Wks. (Germany).....	7s	1945	k 95½	....	....
Scranton Electric.....	5s	1937	101½	101½	102½
Seattle Elec.....	5s	1930	100½	100½	101½
Seattle Elec.....	5s	1929	99½	99½	100½
Seattle Elec.....	5s	1939	93½	92½	94½
Seattle Ltg.....	5s	1949	93½	90½	94
Servel Corp.....	6s	1931	k102½	99½	104½
Shawinigan Wtr. & Pwr...	5s	1934	100½	100	101½
Shawinigan Wtr. & Pwr...	5½s	1950	104½	103½	104½
Shawinigan Wtr. & Pwr...	6s	1950	104½	104½	105½
Sheboygan Elec.....	5s	1946	97½	94½	98½
Siemens & Halske.....	7s	1928	k 99½	96	100½
Siemens & Halske.....	7s	1935	97½	94	97½
Sierra & San Fran. Pwr...	5s	1949	k 94½	....	....
Sierra & San Fran. Pwr....	6s	1949	k 89	....	....
Sioux City Gas & Elec....	6s	1947	102½	101½	102½
Sioux City Gas & Elec....	6s	1949	102½	102	103½
So. Caro. Gas & Elec.....	6s	1942	93	78	97
So. Caro. Gas & Elec.....	6s	1932	79	70	82
Southeast Pwr. & Lt.....	6s	2025	k 93½	89	94½
So. Cal. Edison.....	5s	1939	k100½	....	....
So. Cal. Edison.....	5s	1944	99	98	99½
So. Cal. Edison.....	5½s	1944	104½	103	105
So. Cal. Edison.....	6s	1943	103½	102	104
So. Cal. Edison.....	6s	1944	k105½	....	....
So. Cities Utilities.....	8s	1931	99	99	102
Southern Colo. Power....	6s	1947	98½	97½	99½
So. Ind. Gas & Elec.....	6s	1947	k 99	....	....
Southern Pwr.....	5s	1930	100½	100	101
So. Public Utilities.....	5s	1943	100½	100	101½
So. Sierras Pwr.....	6s	1936	k103½	....	....
So. Wisconsin Pwr.....	5s	1938	92½	91	93
Southwestern Gas & E....	5s	1932	97½	97	98½
Southwestern Gas & E....	6s	1957	98	97½	99½
Southwestern Lt. & Pwr..	6s	1937	98	98	99½
Southwestern Power.....	6s	1944	96½	96½	98
Southwestern Pwr. & Lt..	5s	1943	96	94	96½
Southwestern Pwr. & Lt..	6s	2022	94½	94	96½
Southwestern Pub. Serv..	6s	1945	93½	94	96
Southwestern Utilities....	8s	1936	100	92½	96
Springfield Ry. & Lt.....	5s	1926	98½	99	100½
Standard Elec. of Cal....	5s	1939	100	99½	101
Standard Gas & Elec.....	6s	1935	k100½	....	....
Staten Island Edison.....	6½s	1953	105½	106	107½
Superior Water, Lt. & Pwr.	5s	1933	94½	94½	95½
Syracuse Ltg.....	5s	1951	101	100	101
Syracuse Ltg.....	5½s	1954	104½	103½	104½
TAMPA ELEC.....	5s	1933	k100	....	....
Tenn. Elec. Pwr.....	6s	1947	k105½	....	....
Tenn. Pwr.....	5s	1962	96	96	97
Tex. Pwr. & Lt.....	5s	1937	99½	98½	100
Tex. Pwr. & Lt.....	6s	2022	97½	95½	97
Tide Water Pwr.....	6s	1942	102	100	101½
Tide Water Pwr.....	7s	1937	103	100	107
Toho Elec. Pwr. (Japan).	7s	1955	k 92½	....	....
Tokyo Elec. (Japan).....	6s	1928	k 98½	....	....
Toledo Edison.....	5s	1947	100½	100	100½
Toledo Edison.....	7s	1941	k108½	....	....
Toledo Gas, Elec. & Htg.	5s	1935	100	98	100½
Toledo Tr., L.&P. (notes)	5½s	1930	98½	98	99½
Topeka Edison.....	5s	1930	99	99	100
Topeka Ry. & Lt.....	5s	1933	94½	94½	96½
Trenton Gas & Elec.....	5s	1949	102½	100½	102½
Tri-City Ry. & Lt.....	5s	1930	k 98	....	....
Twin State Gas & Elec...	5s	1953	96½	95	96½
Twin State Gas & Elec...	5½s	1945	99½	98	100
Tyrol Hydro-Elec. Pwr...	7½s	1955	96	95½	97½
UJIGAWA ELEC PWR.	7s	1945	91½	92	94
Union Elec. Lt. & Pwr...	5s	1932	101½	100½	102½
Union Elec. Lt. & Pwr...	5s	1933	k100½	....	....
Union Elec. Lt. & Pwr...	5s	1954	100	99½	101
Union Elec. Lt. & Pwr...	5½s	1954	101	100½	102½
United Elec. of N.J.....	4s	1949	88½	87½	89
United Elec. Lt. & Pwr...	4½s	1929	98	98	99½
United Lt. & Pwr. (notes)	5½s	1928	96½	96	100½
United Lt. & Pwr.....	5½s	1959	96½	96	97½
United Lt. & Pwr.....	6½s	1974	97	95½	98½
United Lt. & Rys.....	5s	1932	k 96½	....	....
United Lt. & Rys.....	6s	1926	99½	100	101½
United Lt. & Rys.....	6s	1952	100½	99	101½
United Lt. & Rys.....	6s	1973	90	89½	92
United Pwr. & Lt.....	6s	1944	102	102	103½
United Water, G. & E....	5s	1941	95	94	95
Utah Lt. & Trac.....	5s	1944	k 90½	....	....
Utah Pwr. & Lt.....	5s	1944	k 96½	....	....
Utah Pwr. & Lt.....	6s	1944	103	102½	104½
Utah Pwr. & Lt.....	6s	2022	94	88½	94½
Utica Elec. Lt. & Pwr....	5s	1950	102½	100½	102½
Utica Gas & Elec.....	5s	1957	102	100½	102½
Utica Gas & Elec.....	5½s	1949	104½	103½	104½
VERMONT HYDRO-ELEC..	6s	1929	100	100	101
Vicksburg Lt. & Trac....	5s	1932	94½	93½	93½
Virginian Pwr.....	5s	1942	98½	88	99
Virginian Pwr.....	6½s	1954	m105½	103	104½
Virginia Ry. & Pwr.....	5s	1943	98½	97½	99½
Virginia-Western Pwr....	6s	1953	105	101½	106½
WAGNER EL. MFG...	7s	....	b100½	100	101½
Washington Coast Util...	6s	1941	102½	102½	103½
Washington Ry. & Elec...	4s	1951	f 81½	....	....
Washington Ry. & Elec...	6s	1933	j103½	....	....
Washington Wtr. Pwr....	5s	1939	102	101½	102½
West Penn Pwr.....	5s	1963	102	99½	102½
West Penn Pwr.....	5s	1946	101½	99½	102½
West Penn Pwr.....	5½s	1953	105½	104½	106
West Penn Pwr.....	7s	1946	106½	105½	108½
W. Va. Lt., Ht. & Pwr....	6s	1929	101½	101	102½
West Virginia Utilities....	6s	1935	98½	95½	99
W. Va. Water & Elec.....	6½s	1942	m103½	102½	104
Westchester Ltg.....	5s	1950	103	102	103½
Western Elec.....	5s	1944	k103	....	....
Western N. Y. Utilities...	5s	1946	97½	96½	98
Western Pwr.....	6½s	1954	100½	100	102
Western Power of Canada	5s	1949	94½	94	95½
Western Pub. Service....	6s	1950	99	98	99½
West States Gas & Elec..	5s	1941	100	98½	99½
West States G.&E. (notes)	6s	1937	94½	94½	96
West States Gas & Elec..	6s	1947	k100	....	....
West United Gas & El....	5s	1950	102	101½	102½
Westphalia Un. Elec. Pwr	6½s	1950	m 98½	....	....
Westinghouse El. & Mfg.	7s	1931	k106½	....	....
Wheeling Elec.....	5s	1941	99	99	100
Wichita R. R. & Lt.....	5s	1932	85½	83	88
Winnipeg Elec.....	6s	1954	97	96	97½
Wisconsin Elec. Pwr.....	5s	1954	99½	98½	100
Wisconsin Gas & Elec....	5s	1952	k 99½	....	....
Wis.-Minn. Lt. & Pwr....	5s	1944	k 97	....	....
Wisconsin Pwr., Lt. & Ht	5s	1946	93½	92	94½
Wisconsin Pub. Service...	6s	1952	101½	101	102½
Wis. Ry., Lt. & Pwr.....	5s	1933	95½	94½	96½
Wis. River Pwr.....	5s	1941	93½	92½	94
Wolverine Pwr.....	7s	1943	101½	100	101½
YADKIN RIVER PR..	5s	1941	k100½	....	....
Yarmouth Lt. & Pwr.....	5s	1937	83	83	87
Yarmouth Lt & Pwr.....	8s	1951	102	99	102

Stock Exchange: aChicago; bSt. Louis; cPhiladelphia; dBoston; eBaltimore; fMontreal; gCincinnati; hSan Francisco; iPittsburgh; jWashington. kBid, low, high, Tuesday, May 4. lBid, low, high, Wednesday, May 5. mLatest quotations available. n1925.

Manufacturing and Markets

American Industry and Legislation

Second in a Series of Articles Discussing the Interest of the Industrial Executive in Certain Important Economic, Political and Social Questions

BY JAMES A. EMERY
General Counsel National Association of Manufacturers

THE soundness and stability of American public policy bears an intimate and vital relation to the progress and prosperity of our industry. In foreign relations it is expressed through treaties and executive action; in domestic affairs through local and national legislation, which in its turn is colored by the interpretation and enforcement of administrative bodies.

During the past quarter century, in particular, whenever anything goes wrong legislation, in large or small doses, has become an accepted remedy. "We do not give ourselves time," declared a distinguished member of the Senate, "to study the conditions or consult the precedents so as to determine whether the symptoms point to a serious disorder or mark a mere irregularity in an otherwise normal and healthy development, or, indeed, whether they simply indicate a perfectly proper but unfamiliar condition, due to the great changes which are continually taking place in our modern life." But, quite apart from its merits or defects in form and substance, the rising tide of actual and potential legislation threatens the business life of the United States with a flood of restriction which annually becomes increasingly extensive, complicated and expensive.

VOLUME OF OUR LAWS

Among other characteristics, the overwhelming volume of American regulation is in itself a serious evil. Dr. Dicey of Oxford observes that Congress and the states annually enact more legislation than is proposed for the collective consideration of the parliaments of Great Britain, Germany, France, Austria and Italy. It must be observed that we possess unusual plant facilities for quantity production. In addition to a headquarters staff of more than five hundred members of the Congress, which has remained in almost continuous session for several years past, we maintain branches in forty-eight states, employing more than four thousand operatives, while a numerous host of aldermen, supervisors, trustees and selectmen man the subsidiaries in more than 16,000 incorporated cities and towns and 3,000 counties. Bills, the raw material of legislation, pile up in the national and local law shops annually in numbers which easily reach into six figures. Exclusive of municipal and county ordinances, the statutory production of Congress and the states has approximated 12,000 yearly during the past decade.

Competent authority assures us that we now live, in federal and local government, under the daily operation of more than a million and a half enactments. Each of these, in turn, may prescribe simple or complicated regulations. "The laws of the forty-eight states in 1923," says a former Solicitor General of the United States, "filled 5,567 volumes of 1,192,000 pages." "A well-informed police officer needs a working knowledge of not less than 16,000 statutes and ordinances which he is presumed to aid in enforcing," remarks a reliable authority upon administration.

Custom, the foundation of law and the basis of conduct, is lost. The individual and the corporate organization, with reference to person or property, is less and less able to determine rights and duties readily by turning to fixed rules. With the steady enlargement of administrative law they must with increasing difficulty and expense undertake to conform conduct to the probable viewpoint of an increasing number of boards and commissions. These, in their turn, steadily multiply in number and authority until the Secretary of Commerce informs us that not fewer than two hundred are scattered through the government departments, while not fewer than forty operate independently.

Legislative activity, particularly in social questions, is greeted with satisfaction by many who, dissatisfied with the slow but permanent influence of education, religion and the councils of the fireside, see progress stimulated by enlarging the sphere of government. They would have the state interfere, not whenever it must, but whenever it can. There are, in addition, well-organized minorities who seek on every occasion to impose their will upon their fellows, or with the aid of a statute to experiment with their liberty or property.

FIVE CONSIDERATIONS

The electrical industry should feel a peculiar interest in meeting this condition. For, apart from both the complications and uncertainties which arbitrary change always threatens, the development and use of power, light, heat, communication and transportation are peculiarly fertile fields for national and local regulation and experiments in public operation and supervision. Remedial considerations for the condition confronting us ought, therefore, to make a peculiar appeal to this ever-expanding industry. It is worth while to keep the following points in mind:

1. Legislation writes rules for the millions, and litigation, however important, affects but a limited number. The quantity and quality of government intervention is a business study of the first importance.

2. Committees of the state and national legislatures are the cradles or the graveyards of legislation. Industrial executives should be prepared, when important measures are under consideration, to give such committees the benefit of their special knowledge and experience. Moreover, by timely, well-informed discussion with their representatives before the bodies to which they belong convene, when legislators have the time, and generally the desire, to obtain accurate information respecting pending proposals, business men make a helpful contribution to sound political thinking. Home is a better forum than Washington.

3. Many states are re-examining their constitutional structure. Some, like Maryland, are reaching the conclusion that less frequent sessions of the legislature would save no inconsiderable public expense and lessen the volume of legislation. Is Georgia, with an annual legislative expense of $135,000, better governed than its neighbor Alabama, with a larger population, an annual legislative expense one-third that of Georgia and a quadrennial assembly? Is it not worth while for the people to consider whether states enjoying annual sessions of the legislature might with profit make them biennial or quadrennial?

4. Sound local government is the foundation of all good government. If, in the reorganization of their political framework, the states which hold elections in even years would change them to odd years, the confusion between local and national issues would be ended. How much could be gained for good government if we corrected that unhappy condition which too frequently permits local questions to be badly decided and bad candidates to be elected under the dominating influence of some overshadowing national party issue!

5. How great would be the gain if business leadership would ardently join in directing public attention to the demoralizing and unnecessary multiplication of regulation which, in the language of Phillips, "kills all self-help and energy of the governed." How important it is, in the sobering administration we at present enjoy, to recall to our people the importance of again realizing in our every-day life the limitations which Lincoln, with his usual clarity, placed about the intervention of the state. "The legitimate object of government," he said, "is to do for a community of people whatever they need to have done, but cannot do at all or cannot so well do for themselves in their separate and individual capacities. In all that the people can individually do as well for themselves government ought not to interfere."

Business Conditions

IMPROVEMENT is noted in buying in the industry, and manufacturers report total sales to be better than they were last year to date. Indications are encouraging for the continuance of the prosperity which has obtained during recent months. Switching equipment manufacturers report a large increase in business, and preliminary reports from more than one hundred manufacturers who will exhibit at the forthcoming N. E. L. A. convention show a decidedly optimistic attitude based on the excellent business enjoyed so far this year. Industrial plants are active in many sections of the country. A heavy movement of electrical apparatus to lumber-mill and manufacturing sources on the Pacific Coast this year is indicative of the rapid progress being made toward complete electrification of industry.

In New England small-motor sales are active and the trend is very encouraging. Industrial electric heating continues to attract much interest, more activity in buying is manifested in other lines, and there is a large amount of new work ahead. Industrial sales show an improvement in the New York district, and a fair amount of diversified central-station buying is in evidence. In the Southeast textile and other industrial plants are active, and central-station construction programs have been productive of many orders. Building and industrial equipment are in good demand in the St. Louis district, and many new projects are contemplated. In the Middle West the volume of business transacted indicates that general conditions are good, and an upward trend is noted. On the Pacific Coast lumber mills have been very active buyers, and a number of orders and inquiries have been noted for bare copper wire. Distribution transformers and motors have been in particularly good demand.

Non-Ferrous Metal Market Quiet —Prices Well Maintained

Sales of copper and zinc have been particularly small, and the non-ferrous metal market has been quiet. The demand for lead is an exception to the general condition, that metal having sold in good volume. Tin has also been in demand, possibly owing to the probability of a shortage with the English production stopped. Despite the few sales made the price of copper has been well maintained. Recent offers by a large electrical manufacturer to buy at 13¾ cents have apparently met with no response. Sellers are optimistic and in no mood to make concessions in price.

NEW YORK METAL MARKET PRICES

	April 28, 1926 Cents per Pound	May 5, 1926 Cents per Pound
Copper, electrolytic	13.925	13.825
Lead, Am. S. & R. price	7.85	7.85
Antimony	17	14⅝
Nickel, ingot	35	34
Zinc, spot	7.15-7.20	7.10-7.15
Tin, Straits	63	64⅛
Aluminum, 99 per cent	28	28

Base copper price May 5, 1926, 16¼ cents

Textile and Other Industrial Plants Active in Southeast

In addition to the two large definite textile projects announced in the Southeast last week a considerable number of active prospects are in hand, with the outlook bright for the closing of construction work on additional mills within the next 30 days. Activities in other industrial fields are reflected in the receipt of orders from the steel interests in the Birmingham district for rolling-mill motors, high-tension transformers and other electrical construction materials for the electrification of an addition to an existing Birmingham plant. A large cement mill in middle Georgia made announcement this week of its proposed electrification, and the work will be undertaken immediately.

Central-station activities are keeping pace with the industrial plants. Reports of the projected construction of a plant on the Pee Dee River in the Carolinas are current, and the Tennessee Electric Power Company has resumed construction activities, under the name of the Toccoa Power Company, of a hydro-electric development in northeast Georgia. Orders for distribution materials continue to be very satisfactory, and pole purchases have reached the point where considerable delay is experienced in shipments of creosoted pine poles in 35-ft. and 40-ft. lengths.

Small Motor Sales Active In New England District

Small-motor sales are increasing in the New England district, and the trend at the present time is particularly encouraging. One manufacturer reports a marked increase in sales during the past week as compared with previous weeks, with orders, for the most part, for single motors. Another manufacturer records many orders for large lots, one of 45 units for loom-drive, another of 40 units for the same purpose and one of 300 from a manufacturer of oil-burning equipment. Industrial electric heating is attracting much interest. Power equipment sales are showing greater strength, and turbo-generator units are in demand. A prominent manufacturer reports a sale of a 3,500-kw. unit to a Rhode Island wire manufacturer, and another records much interest in the paper industry and a growing activity in metal-working industries, particularly in southern New England.

New construction supplies and equipment are moving well, with contractors asking for prices and deliveries on wire, pipe, hardware and cable. Central-station companies are buying replacement equipment and supplies, and a good volume of small-lot orders is recorded by a number of jobbers. Household appliance sales show a more favorable trend for the past week as compared with previous weeks. More activity in buying is manifested in other lines in this district, and much optimism prevails with a large amount of new work ahead.

Upward Trend of Business Noted in Middle West

The volume of business transacted in the Middle West indicates that general conditions are universally good. Manufacturers report an increasing trend of business, and building operations are encouragingly good. The threatened tie-up of building activity is apparently terminating in an amicable settlement. The various utilities companies are busy with construction work, a great deal of underground extension of service being under way. Several interesting orders for apparatus included boiler, superheater, economizer, air-heater equipment, etc., valued at $175,000; spare turbine parts, approximating $50,000, and large quantities of cable. There has been a good demand for pole-line hardware.

Industrial Sales Show Improvement in New York District

Industrial sales in the New York district show a slight improvement over the previous week, although the volume of business in this field is not so great as might be desired, according to some manufacturers. Those companies making control apparatus particularly report that the market for their apparatus was very poor all last month, although sales in the last few days showed a little betterment. A fair amount of diversified central-station buying is in evidence, although there are no particular orders of any considerable magnitude reported. Sales of pole-line hardware and switching equipment are quiet, the demand for April being considerably below that of the earlier months of the year. In the jobbers' field the demand for building construction materials is light, with some improvement in the appliance market.

Building and Industrial Equipment Active in St. Louis District

Good demand for building equipment continues in the St. Louis district. Builders of switchboards report excellent business in the Southwest, especially from hotels, office buildings, municipal buildings and country clubs. One switchboard builder has contracts for six months ahead, and there is no indication of a let-up in orders. An architect in San Antonio has $6,000,000 of large construction in his office and says there is plenty more in sight. New Orleans has lately taken on new life, there being several public buildings in the course of design and construction. The idea which the large power companies are pushing—namely, selling primary current to the larger consumers—has created a good market for industrial substation equipment, transformers, oil switches, etc.

The uncertainty of the coal situation in the southern Illinois field has caused a marked lull in the development of industries in that part of the state. There is a demand for electrically driven pumps in the rice fields of Arkansas, and the general demand for transmission and building material is up to normal. In and near St. Louis a

number of orders have been placed for motor-driven shoe machinery. The manufacturing chemical companies are buying motors and heating units. Cement companies are working full time and buying electrical equipment freely. The flour mills in this district are buying very little, and report no projected expansion. Present mills are only supplying the regular trade. This condition is said to have been brought about by the very small export demand for American flour. Central-station business continues normal, but is tending toward more and smaller orders.

Lumber Mills Active Buyers on the Pacific Coast

Heavy orders and inquiries for bare wire have been noted on the Pacific Coast. A railroad is in the market for 120,000 lb. of No. 8 bare copper wire and a Philippine Island telephone company for 130,000 lb. bare iron wire and 30,000 ft. ⅜-in. single galvanized strand. Contractors' business is fair generally, though excellent in certain items reflecting special conditions, orders such as two and one-half carloads of conduit for commercial buildings and 200 safety switches for pumping plants being placed. One manufacturer in San Francisco reports the sale of over 600 motors in sizes from 5 hp. to 15 hp. during the week. Distribution transformers are also selling exceptionally well. An average weekly sale of 400 units in sizes from 3 kva. to 100 kva. is reported by one manufacturer. An order for six transformers, valued at approximately $15,000, has been placed by a northern California power company, and another central-station company has purchased about $75,000 worth of switchboards and accessories.

The Great Northern Railway Company has announced the purchase of about $1,000,000 worth of electrical equipment in connection with its program calling for the electrification of 104 miles of track. A lumber company has signed a contract for a 1,500-kw. turbo-generator, switchboard and miscellaneous power-house equipment, and another company placed a large order for electrical equipment. A manufacturer also reports the sale of a 1,000-kw. turbo-generator unit to a Puget Sound mill and a 500-kw. unit to a lumber company in Lewis County. Two contracts were reported as having been signed, one calling for ten motors and the other for nine units ranging in size from 5 hp. to 75 hp. The city of Tacoma is expected to request bids at an early date for street-lighting equipment.

Activities of the Trade

Refrigerator Distributors Form Co-operative Organization

At a meeting held in San Francisco April 13 a distributor organization was formed for the co-operative development of the electric refrigeration market in northern California. The meeting was called at the request of J. Robert Crouse, the founder of the Electric Refrigeration Manufacturers' Council and vice-president of the Electric Refrigeration Corporation. A similar distributors' organization had previously been formed in Cleveland by Mr. Crouse. Distributors of eight refrigerator manufacturers and representatives of the two local central-station companies were in attendance.

The organization will function in a state-wide capacity and will work in co-operation with the California Electrical Bureau. R. E. Fisher, vice-president in charge of public relations and sales of the Pacific Gas & Electric Company, was elected chairman; F. H. Woodward, general sales manager of the Great Western Power Company, vice-chairman, and Victor W. Hartley, secretary of the California Electrical Bureau, was named secretary.

Corning Glass Works Enters Electrical Transmission Field

The Corning Glass Works, Corning, N. Y., announces its entrance into the electrical transmission field with high-tension and low-tension "Pyrex" insulators. The company states that many years of intensive research has proven that "Pyrex" insulators have the required qualities necessary for a perfect insulator. These qualities are said to be low coefficient of expansion, low temperature rise with uniform temperature throughout, transparency permitting ease of inspection, non-hygroscopic, high puncture strength, permanent and uniform dielectric, quick drying surface, and the ability to withstand concentrated power arcs. Several thousands of these insulators are said to have been in service on the Montana Power system for about two years.

At the present time the company is offering pin-type insulators of a one-piece design for operating voltages from 6,600 to 50,000. Development work is at present proceeding on suspension and flange or stack-type units and further announcements regarding these will be made later. The sales office of the company is at 501 Fifth Avenue, New York. Raymond W. Lillie is manager of sales of the insulator division.

General Electric Gets Turbine Orders from the South

Increased power demands in the South have resulted in considerable additions to central-station facilities this year. The General Electric Company has received several orders for turbine units as follows: In Florida two new stations are being built, and orders for three 25,000-kw. units for these stations have already been placed. In Texas a total of four 12,500-kw. units are being added to the central-station plants at Dallas and Houston. The Phoenix Utility Company has purchased for the Florida Power & Light Company two 25,000-kw. turbines for Fort Lauderdale; two 12,500-kw. turbines have been ordered by the General Engineering & Management Corporation for the Florida Power Company at Dunnellon, and the Houston Lighting & Power Company is adding a 25,000-kw. unit to its Deepwater plant, which now has installed a capacity of 40,000 kw.

Power Specialty Company Buys Aero Pulverizer Company

The Power Specialty Company, 111 Broadway, New York, announces the purchase of the Aero Pulverizer Company, 90 West Street, New York, which has been making coal pulverizers for many years. The company states that the acquisition of the Aero concern now places it in a position to contract for a complete steam generating unit, including any make of boiler desired by the customer. The products previously sold by the Power Specialty Company include water-cooled furnaces, radiant-heat and convection-heat superheaters, Foster economizer and three types of air heaters.

The Consolidated Lamp & Glass Company, Coraopolis, Pa., in connection with its "Shade-O-Tone" units, has developed a sales program for the central-station companies for increasing residence lighting load.

The Square D Company, Detroit, manufacturer of electrical safety devices, announces that it has placed on the market a new line of both the sealed-main-fuse type and the accessible-main-fuse type of meter service switches.

The M. S. Wright Company, Worcester, Mass., manufacturer of "Sweeper-Vac" electrical appliances, announces that its new "Sweeper-Vac" electric cleaner is provided with a floor-polishing attachment for hardwood floors.

The Remington Typewriter Company, 374 Broadway, New York, announces that it has placed on the market the new Remington electric typewriter.

The International General Electric Company announces that H. B. Pierce has been named manager of the Berlin office, succeeding L. A. Trone. Mr. Pierce has been with the International company since 1917, when he had charge of sales in China. In 1919 he went to Japan for three years. Since then he has been engaged in special work for the company on Russian and Far Eastern matters.

The Westinghouse Electric & Manufacturing Company has recently placed on the market a new non-automatic cabinet range, known as the "Console" range. The company states that this range has been designed to meet the demand for an inexpensive cabinet range with large oven capacity and is similar in all important points of design and construction to the Westinghouse "Junior" cabinet range.

The Barnett Foundry & Machine Company, Lyons Avenue and Coit Street, Irvington, N. J., manufacturer of the "Capitol" electric ironers, announces that Glenn A. Wilson, formerly Eastern district manager of the Coffield Washer Company, has been appointed sales manager. Mr. Wilson will make his headquarters at the main office and works of the company at Irvington,

N. J. The company is planning an active selling campaign of a small-sized popular-priced model which it has recently placed on the market under the name of the "Capitol Junior" electric ironer.

The Trico Fuse Manufacturing Company, Milwaukee, announces that it has placed on the market a new non-renewable plug fuse, known as the "Cleartop."

Copeland Products, Inc., Detroit, manufacturer of electric refrigerating systems, reports that its total net sales for the first quarter of 1926 were 70 per cent of the entire sales of the company in 1925. Shipments of electric refrigerating systems for the first quarter of this year were 60 per cent of the total shipments made in 1925, and the number of sales outlets for the first quarter of the year showed an increase of 57 per cent over the total outlets that the company had in 1925.

The Roach Appleton Manufacturing Company, 3982 Barry Avenue, Chicago, manufacturer of switch boxes, ground clamps, etc., has placed on the market a new laundry outlet box known as the "Raco RL," in which a polarity-type receptacle is attached to the mounting plate by two eyelets. These boxes are an adaptation of the regular "Raco" switch boxes and can be readily assembled in gangs.

The Westinghouse Electric & Manufacturing Company announces that three new percolators, a new electric hot plate and a table stove have been added to its domestic line.

New Equipment Available

Polyphase Watt-Hour Meter with Indicator Lamp

An indicating device to show that the potential coils of a meter are energized has been introduced by the General Electric Company in its type D-7 polyphase watt-hour meter. An interruption of the potential circuit on one element of the ordinary polyphase watt-hour meter is not always easy to detect; a blown fuse may go undetected for some time, and in the meantime the meter registers only a portion of the power being delivered. A few turns around the outside of the potential coil of each element serves as a transformer to energize a small, low-voltage lamp on the front of the base of the meter. One lamp is used for each element. A lamp "out" means an open potential circuit, quickly detected by the meter reader or operator, and corrected with a minimum loss of revenue.

Fused Switch

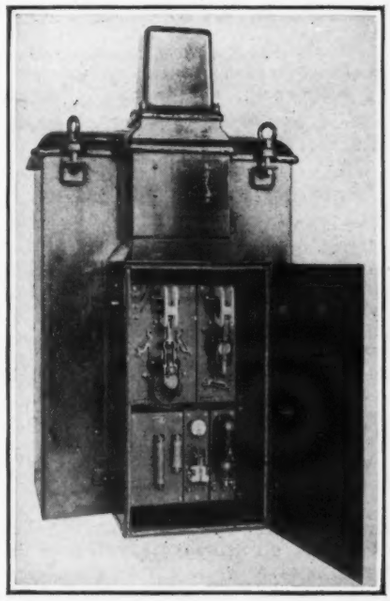
An underslung "Fuswitch" of the open type has been placed on the market by the W. N. Matthews Corporation, St. Louis. The switch is available for voltages of 15,000 or less and for a maximum capacity of 100 amp. The contacts of this switch are said to be made of the best material, and the contact clips are reinforced by heavy springs to keep them in alignment. The upper contact clip has an extra rib which causes the upper cartridge contact to clamp into place to prevent it from falling out in case of a severe jar or jolt.

One-Piece Secondary Racks

A new line of one-piece secondary racks adapted to all phases of secondary installation has been placed on the market by the Truscon Steel Company, Youngstown, Ohio. Rivets, bolts, nuts and washers are eliminated on this rack, and the design is such that no matter how it is mounted the rack permits the free handling of wires owing to the smooth curved surfaces. Tested under actual field conditions, this type of rack is said to have withstood all the necessary strains or pulls found in general practice. The rack permits of all the various spacings that the assembled type rack had with the addition of two new spacings—the four-spool 8-in. spacing and the three-spool 12-in. spacing. All sizes and types of these one-piece racks are available in the standard back and the extended back.

Synchronous Motor Control

A completely self-contained, oil-immersed automatic starter for 2,300-volt synchronous motors has been developed by the Electric Controller & Manufacturing Company, 2700 East 79th Street, Cleveland. The starter is built for



SELF-CONTAINED AUTOMATIC STARTER FOR 2,300-VOLT SYNCHRONOUS MOTORS

across-the-line starting of low-speed motors and for reduced voltage starting of the higher-speed motors. It is of the push-button-control type, the field excitation being automatically applied as the motor approaches synchronous speed.

The reduced-voltage starter consists of a welded boiler-plate tank which contains an automatic double-throw switching mechanism, a power transformer for providing starting voltage, potential transformers for providing the 220 volts necessary for the master-switch operating current and the current-limit transition relay, which connects the motor to full voltage when it has been accelerated to approximately 85 per cent of synchronous speed. On the outside of the tank there is a dust-proof steel cabinet which incloses a field-switching mechanism, a field-discharge resistor, a timing relay and a direct-current field ammeter. This cabinet may also contain an automatic starter for operating a magnetic clutch if desired. The full-voltage starter is of similar construction except that the starting auto-transformers are omitted. The equipment is complete in a single unit.

Small Circuit Breaker

The "Sentinel" circuit breaker for protecting the motor and mechanism of washing machines, ironers and other electrical appliances from overloads has been designed by the Westinghouse Electric & Manufacturing Company. This new breaker is also used as the main starting and stopping switch. If too great a load is applied to the motor, a thermostat, affected by the heat generated by the overload current, trips the breaker and prevents serious damage. The breaker is completely inclosed in a composition case and is fastened to the appliance by two bolts. The only moving part exposed is the handle on the bottom of the case by which the current is turned on or off. All the terminals lie under the removable cover plate, the leads being brought through the breaker from the back.

Slide Rule

A slide rule for the quick tabulation of line loss and voltage drop has been placed on the market by C. C. Moler, distribution engineer the Potomac Edison Company, Hagerstown, Md. In the operation of the slide rule no constants or formulas are required. A setting of the voltage, the load and the power factor on a curve for the wire size are all the operations that are necessary. The loss can then be read directly on the indicator. The rule is intended primarily for distribution work, but the reverse side of the voltage slide can be turned up and is scaled to 100,000 volts and 200 miles, making the rule useful in transmission work not taking into account charging current. The dimensions of the rule are approximately 10 in. x 2 in. x ½ in.

Diesel Engines

A new line of Diesel engines, in which the "en bloc" type of frame has been adapted for engines of over 300 b.hp., has been placed on the market by the Fulton Iron Works Company, St. Louis. This "en bloc" type construction of the frame is said to provide a rigidity comparable to that of a solid casting when bolted to the bedplate and permits of a perfect permanent alignment. The engines are of the four-cycle air-injection type and are started by low-pressure

air, not exceeding 250 lb. per square inch. Air for starting is admitted to each cylinder up to and including the six-cylinder sizes and on six cylinders of the eight and ten-cylinder engines. Air is admitted through an automatic valve which does not open until the cylinder pressure is below that of the starting gear. The fuel-oil pump operates at low speed direct from the crankshaft.

Two independent lubricating systems are used. The main bearings, crankpin bearings and piston-pin bearings are lubricated by oil under pressure, and the cylinder walls are lubricated at two points 180 deg. apart, each point being supplied with fresh oil by an individual mechanical force-feed pump, which can be finely adjusted to insure proper lubrication. The governor, of the Jahn type, is mounted directly on the bedplate of the engine and is driven by a helical gear from the crankshaft through a flexible coupling. The governor regulates the speed of the engine to approximately 2 per cent and will not vary over 3 per cent from no load to full load, if the load is suddenly applied or removed. A three-stage air compressor used on all Fulton-Diesel engines is built integral with the engine and is driven direct from the main shaft. The compressor has its own separate force-feed lubricator with three plungers and individual sight feeds.

Sectionalizing Unit

A combination oil switch and manual "disconnect" furnished in three different forms has been developed by the G. & W. Electric Specialty Company, 7776 Dante Avenue, Chicago. The switch is available in a form for use as a sectionalizing switch between two underground lead-covered cables, suitable for use in a manhole or above ground, as a junction between underground cables and overhead wires, and as an overhead sectionalizing switch.

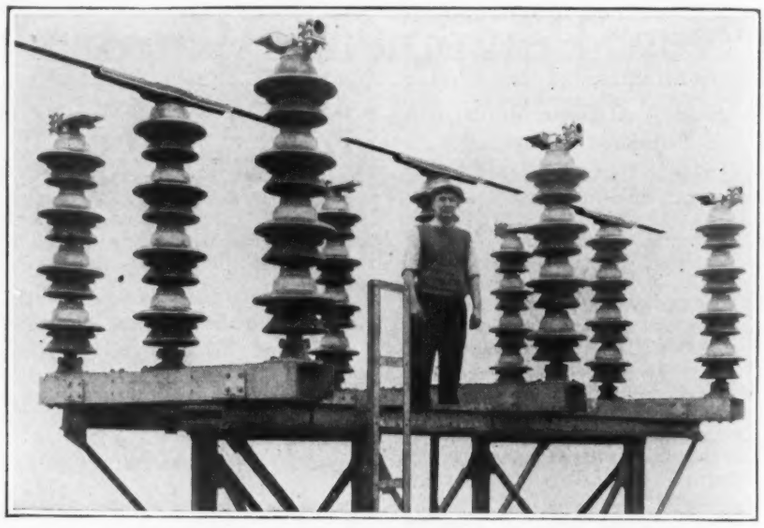
The unit, in compact form, is protected by disconnects on both sides. In sectionalizing the feed may be from either side of the unit. This oil disconnect is said to take up no more room than an ordinary switch and can be disconnected from the line entirely, even to the extent of substituting an entirely new switch without disturbing any permanent line connections. The unit is made for two, three or four conductors in 200-amp. and 400-amp. capacities for voltages up to 6,600.

Motor Trolley for Small Hoists

A new motor-driven trolley has been developed by the American Engineering Company, Philadelphia, for use with its ½-ton and 1-ton class A "Lo-Hed" electric hoists, which previously have been built in bolt-suspension and plain-trolley types only. The trolley can be supplied with a travel speed of 80 ft. or 120 ft. per minute and can be arranged for remote control if desired. Any class A "Lo-Hed" hoist now in service can be easily converted into a motor-trolley hoist by adding the new trolley. Only 22-in. headroom is required for hoist and trolley. The three main castings, from which the hoist and load are suspended, are of cast steel. The spur-gear drive is totally inclosed and runs in an oil bath. Hyatt roller bearings are used on all shafts, and the motor is totally inclosed and uses ball bearings. All parts are completely accessible and the motor can be removed readily when necessary. The motor can be furnished either for direct current or for two-phase or three-phase alternating-current service.

Air-Brake Switch

A 132-kv. horizontal three-pole motor-operated air-break switch designed for extra-heavy duty has been placed on the market by the Delta-Star Electric Company, 2400 Block, Fulton Street, Chicago. The rotating insulators are mounted on ball bearings and self-aligning contacts and in connection with the double-action blade mechanism are said to permit of easy operation under severe winter conditions.



132-KV. HORIZONTAL AIR-BREAK SWITCH IN OPEN POSITION

Automatic Circuit Breaker

The Maple circuit breaker and switch designed for the operation and protection of small motors from overload and short circuits has been placed on the market by the R. H. Maple Company, Indianapolis, Ind. The circuit breaker is of the magnetic-type plain overload and carries a double set of contacts—one to carry the current and the other to take the arc in breaking the circuit. The armature trip is of the hammer-blow type and has from 25 per cent to 50 per cent more power than is required to operate the switch. The closing and opening manual operations are similar to those of an ordinary toggle switch. By means of a screw the travel of the armature to and from the coil is readily adjusted to obtain the desired capacity.

Gang-Type Standardized Switch.—A new gang-type standardized switch, which combines in one device the switch and an inclosed dead-front cut-out for branch circuit distribution, has been placed on the market by the Square D Company, Detroit. The switch, built in the shape of an inverted T, can be ganged without the aid of a trough. The branch fuses are on the front face of the base and are accessible to the customer, being inclosed by the auxiliary cover.

Sleet Cover.—A new type of sleet cover, for outdoor disconnecting switches, that is said to be proof against ice and sleet and will insure easy operation by a stick has been developed by Thoner & Martens, Boston. The cover consists of a slotted jacket of cast bronze with few parts, and there is said to be little possibility of it getting out of order.

One-Piece Dust-Proof Meter Case.—A mahogany-veneered, one-piece "Micarta" portable meter case has been designed by the Westinghouse Electric & Manufacturing Company for standard watt-hour meters. It is made in one piece with its inner layers of the same "micarta" that is used for industrial gears. A tightly fitted nickel-plated brass ring, lined with felt, prevents any dust from entering the box once the meter is inserted. As a protection to the meter when not in use a lid of the same finish as the box is provided.

Pole-Reinforcing Device.—The Laconia Car Company, Boston, is marketing a pole-reinforcing device for overcoming the weakness of wooden poles when decayed below the ground line. This device, it is said, is designed to increase the life of condemned poles by an average of fifteen years. It consists of two wrought-iron members about 5 ft. 4 in. long, shaped to fit the pole surface, which are driven into the ground and clamped in place with marked savings in labor and time. No excavation is required beyond that needed to determine the condition of the butt. The device is being marketed under the trade name "Nepsco" pole reinforcement.

Prefocused Lamp and Socket.—A prefocused incandescent lamp and special socket for use in railway signals, locomotive headlights and motion picture and similar projectors has been developed by the General Electric Company. The new lamp has a special base which when used with the socket assures the filament of the lamp coming in exactly the same position as that of every other one of the same size and type.

New Trade Literature

CENTRIFUGAL PUMPS. — "De Laval Mine Pumps" is the title of a booklet issued by the De Laval Steam Turbine Company, Trenton, N. J., describing the De Laval centrifugal pumps for mine-pumping requirements. Instructions are given for the design of piping and the calculation of friction head required. Details of construction which should be investigated when selecting pumps for this service are also discussed.

MOTORS. — The General Electric Company, Schenectady, N. Y., is distributing bulletins GEA-6, GEA-71 and GEA-246, covering its "G-E" squirrel-cage motors "500" series, types "KT" (three-phase), "KQ" (two-phase), wound-rotor induction motors, types "MT" and "MQ," "900" series, and "G-E" general-purpose synchronous motors "7500" series, types "TS" (three-phase), "QS" (two-phase) respectively.

INSULATING MATERIAL.—The Thermal Syndicate, Ltd., 58 Schenectady Avenue, Brooklyn, N. Y., has issued a booklet describing "Vitreosil" as initiated and developed by the company at its works at Wallsend-on-Tyne, England. This booklet contains the history, manufacture and properties of "Vitreosil," and a list of applications of the product, including apparatus for use in electrical work, radio-therapeutic applications, monochromatic and ultra-violet light apparatus, high-power wireless valves, articles for lighting and heating industries, etc.

HIGH-VOLTAGE TESTING EQUIPMENT.—Pamphlet Ta 156, issued by Ferranti, Ltd., Hollinwood, Lancashire, England, covers the Ferranti high-voltage direct-current testing equipments.

ELECTRIC WIRING DEVICES. — The Beaver Machine & Tool Company, Inc., 625-43 North Third Street, Newark, N. J., has issued catalog No. 6, covering the Beaver products, including attachment plugs, feed-through switches, taps, connectors, receptacles, kitchen unit switch, etc.

WELDING RODS.—The Mueller Brass Company, Port Huron, Mich., is distributing a folder covering the Mueller brass and bronze welding rods. Attention is called to its "Blue Top" Tobin bronze welding rods for general repairing of all kinds.

COPPER FITTINGS.—Bulletin G, issued by the Champion Switch Company, 550 Abbott Road, Buffalo, describes and illustrates its copper fittings for switches, including terminals, connectors, busbar clamps and contact nuts. This bulletin contains a complete price list, dimensions and illustrations of the various types of connectors.

Construction News

Projects, Plans, Bids and Contracts, Contemplated or Under Way

New England States

NEW LONDON, CONN.—Bids will be received by the Bureau of Yards and Docks, Navy Department, Washington, D. C., until May 12 for an automatic refrigerating plant, with a two-ton motor-driven ammonia refrigerating machine, etc.

WALLINGFORD, CONN. — The Ives Manufacturing Company plans to install electric power equipment in connection with the rebuilding of its local tool works.

Middle Atlantic States

ALTMAR, N. Y.—Permission has been granted the Northern New York Utilities, Inc., Watertown, to erect a high-tension transmission line between Altmar and Oswego to link up its Watertown system with the lines of the People's Gas & Electric Company and the Oswego River Power Company.

FABIUS, N. Y.—Application has been made by the Syracuse (N. Y.) Lighting Company, Inc., for permission to extend its transmission lines to and exercise an electric franchise in Fabius.

MASSENA, N. Y.—The Aluminum Company of America, Inc., Oliver Building, Pittsburgh, plans to install electric power equipment at its proposed local wire mill, to cost about $350,000.

NEW YORK, N. Y. — Bids will be received by the New York State Bridge and Tunnel Commission and New Jersey Interstate Bridge and Tunnel Commission, Room 3,004, Woolworth Building, until May 24 for construction of entrance and exit plazas in Jersey City, including pavement, sidewalk manholes, conduits, fire hydrants, electric light poles, meter and transformer chamber, etc., known as contract No. 26 of the Holland Tunnel.

SARATOGA, N. Y.—Plans for rebuilding the coal-handling plant of the Saratoga Coal Company, Inc., recently destroyed by fire with a loss of about $100,000, include an electric power plant.

UTICA, N. Y.—Bids will be received by the State Hospital Commission, Capitol Albany, until May 19 for fire-alarm system for the Utica State Hospital. Separate bids will also be received at the same time and place for replacement electric wiring for the Utica State Hospital.

WEST POINT, N. Y.—Bids will be received by the Quartermaster, United States Army, until May 11, for electrical supplies, including batteries, bells, sockets, switches, conduits, etc.

CAPE MAY, N. J.—Bids will be received by the Mayor and Commissioners of the City of Cape May until May 11 for construction of water works pumping station of 2,300,000 gallons daily capacity as follows: Contract No. 1—For furnishing and installing one 120-hp. and one 180-hp. Diesel engines directly connected to generators, and also one 36-kw. generator and appurtenances. No. 2—Construction of building with foundations for equipment, etc. No. 3—For furnishing and erection of motor-driven centrifugal pumps, vacuum pumps, station piping, switchboard, etc., and heating and lighting systems. Remington & Vosbury, 509 Cooper Street, Camden, are engineers. Paul A. Volcker is city manager.

HOBOKEN, N. J.—Plans have been filed by the Public Service Electric & Gas Company, Newark, for extensions and improvements in its substation at 1502 Bloomfield Street, to cost about $60,000.

NEWARK, N. J.—Bids will be received by the Board of Education, City Hall, until May 12, for electrical supplies, electric time clocks, electric lamps, etc., for the local schools. R. D. Argue is secretary.

HAZELTON, PA.—Plans are under way by the Pennsylvania Power & Light Company, Allentown, for the erection of a rural transmission line for service at Pine View, Albert's Corners and Mount Top.

MAUCH CHUNK, PA. — The Mauch Chunk Silk Company has begun the construction of a power plant at its mill, to cost about $30,000.

MOUNT CARMEL, PA.—The Philadelphia & Reading Coal & Iron Company, Reading Terminal, Philadelphia, plans to install electric power equipment in connection with the rebuilding of its local coal breaker, recently damaged by fire. The cost is estimated at $800,000.

PHILADELPHIA, PA. — Bids will be received by H. E. Ehlers, Director of Department of City Transit, Eleventh Floor, 1211 Chestnut Street, Philadelphia, until May 18 for furnishing and installing synchronous converters and transformers for Mount Vernon, Cumberland and Louden substations of the Board Street Subway. For details see Searchlight Section.

POTTSVILLE, PA.—The construction of a new steam-driven power plant in this district is under consideration by the Pennsylvania Power & Light Company, Allentown, to cost about $1,000,000.

WILMINGTON, DEL. — The Tannin Corporation, 100 East Forty-second Street, New York, plans to install electric power equipment in its proposed local tanning extract plant, to cost about $1,000,000. Emmett Carter is chief engineer.

ANNAPOLIS, MD.—Bids will be received by the Bureau of Yards and Docks, Navy Department, Washington, D. C., until May 12, for improvements in the coal-handling plant at the naval academy. (Specification 5175).

PRINCESS ANNE, MD.—The Board of Commissioners of Somerset County has granted a franchise to Everett C. Cannon, owner of the local electric plant, to erect a transmission line along the State Road from the town of Princess Anne through West Princess Anne and St. Peters Election District to St. Stephens' Church, a distance of 8 miles, and to distribute electricity along the line.

DAVIS, W. VA.—Arrangements are being made by the West Penn Power Company, Pittsburgh, for a proposed hydro-electric development on the Blackwater River, near Davis, which will be carried out as a unit of the Cheat River hydro-electric power development plans.

WASHINGTON, D. C. — Bids will be received by the Board of Commissioners, District of Columbia, until May 11, for electric traffic signals, controls and switches.

WASHINGTON, D. C. — Bids will be received by the Commissioners of the District of Columbia, Room 500, District Building, Washington, D. C., until May 25, for furnishing cast-iron lamp posts and incidental fittings.

WASHINGTON, D. C. — Bids will be received by the Chief Signal Officer, United States Army, until May 18, for ammeters, condensers, transformers, switches, radio receivers and transmitters (Circular C. P. 2330-1).

WASHINGTON, D. C.—Bids will be received United States Engineer Office, 1068 Navy Department Building, Washington, D. C., until May 18 for furnishing, installing and testing three generators, automatic switching and electrical equipment.

WASHINGTON, D. C. — Bids will be received by the Quartermaster, Marine Corps., until May 11, for electrical supplies, including door bells, batteries, push bottons, reflectors, etc. (Schedule 580). Also, until May 13, for one portable electrical automatic refrigerating unit (Schedule 573).

North Central States

ALBION, MICH.—The Michigan Electric Railways Company, Jackson, plans to install electric power equipment in connection with the rebuilding of its local shops recently destroyed by fire with loss of about $600,000.

PONTIAC, MICH.—The Oakland Motor Car Company plans to install electric power equipment in a new addition, now under construction, to cost about $500,000.

CLEVELAND, OHIO. — Bids will be received by the Commissioner of Purchases and Supplies, City Hall, Cleveland, until May 14 for outdoor substation equipment for the Division of Light and Power.

CLEVELAND, OHIO. — Bids will be received at the office of the Commissioner of Purchases and Supplies, City Hall, until May 14 for furnishing power piping and accessories for the Kirkland station of the Division of Water and Heat.

YOUNGSTOWN, OHIO. — The Youngstown Cold Storage Company plans to install electric power equipment in its proposed cold storage and refrigerating plant at 908 West Rayen Avenue, to cost about $600,000.

GREENUP, KY.—Plans for the proposed local factory to be erected by the Grasselli Chemical Company, Guardian Building, Cleveland, include a power plant. The cost of the project is estimated at $3,000,000.

CHICAGO, ILL.—The Illinois Bell Telephone Company, 213 West Washington Street, plans to erect a toll cable line from Peoria to Chicago, 175 miles long, including repeater stations, etc., at Ottawa, Joliet and Chicago, to cost about $2,000,000. G. C. Treadway, 320 Fulton Street, is district manager.

CHICAGO, ILL.—Work will soon begin on the installation of 7,000 new street lamps in sixteen outlying wards. Concrete standards mounted with lamps of 250 cp. will be used. Plans are also under way for installing 600 or 1,000-cp. on Broadway between Leland and Devon; on Indianapolis Avenue from Ewing Avenue to the Indiana state line, and on Northwest Highway from Milwaukee Avenue to Raven Street, and on newly widened streets. Traffic signal lights will be installed at 100 outlying intersections as soon as surveys have been completed. John T. Miller is commissioner of gas and electricity.

OAK PARK, ILL.—The installation of a new street-lighting system in Oak Park is under consideration. The plans provide for 3,500 lamps, to cost about $1,000,000. Dudley Meyers is Commissioner of Public Works.

AMERY, WIS. — Contract has been awarded by the Wisconsin Hydro-Electric Company for a hydro-electric development on the Namakagon River, near Trego to Siems, Helmers & Schaffner, Inc., 514 Guardian Life Building, St. Paul. Contracts have not yet been awarded for structural steel, re-enforcing steel or any power house material. Ralph D. Thomas, Minneapolis, is engineer.

CLINTONVILLE, WIS.—To provide for an adequate supply of energy between the Wisconsin Power & Light Company and

its subsidiary, the Central Wisconsin Power Company both of Madison, about $500,000 will be expended for transmission line extensions and hydro-electric plants in Waupaca and Shawano Counties. The work will include the construction, this summer, of a dam and power house on the Little Wolf River at Big Falls, to cost $65,000; a high-tension transmission line from Big Falls to Clintonville, about 12 miles long. A dam and power house at Hayman Falls, on the Wolf River, 4 miles north of Shawano, to cost $225,000, will be completed. A 65,000-volt transmission line connecting Shawano, Clintonville, Iola, Scandinavia, Wild Rose and other towns, will be erected at a cost of 190,000. Another 33,000-volt line to connect Hayman Falls and Shawano will be built, at a cost of $45,000.

COLOMA, WIS.—Steps have been taken by the local business men to secure the installation of a street-lighting system in the business section.

MADISON WIS.—The Wisconsin Power & Light Company plans to continue the transmission line now being built from New Glarus to Blanchardville west through Hollanddale to Mineral Point, a distance of about 25 miles. The terminus of its main system at Barneveld is to be extended by the erection of a transmission line through Ridgeway to Dodgeville, about 15 miles. Plans are also under way by the company to make extensive improvements to the municipal electric plant at Blanchardville, recently acquired.

WASHBURN, WIS.—Plans have been approved by the Village Council for the electrification of the water-works plant, to replace the present steam equipment.

WHITEWATER, WIS. — Arrangements are being made by the Wisconsin Gas & Electric Company, Racine, to erect a transmission line to Lake Koshkonong to serve a summer resort and rural consumers in that vicinity.

ALBERT LEA, MINN. — Work will begin at once by the Interstate Power Company, Chicago, on the installation of a 7,500-kw. turbo-generator and boiler equipment in its local electric plant.

BUHL, MINN. — The City Council is arranging for an additional bond issue of $40,000, for completion of extensions in the municipal electric plant.

FAIRMONT, MINN. — The Interstate Power Company, Chicago, contemplates extending its transmission line from Fairmont to East Chain Lake.

GRANITE FALLS, MINN.—Bids will be received by the City Council until May 14, for the installation of an ornamental lighting system in the business district.

GREENFIELD, MO.—The Ozark Utilities Company, Bolivar, which has purchased the property of the South Missouri Power Company, contemplates extensions and improvements.

MADISON, S. D.—Bids will be received by the Board of City Commissioners until May 24, for the construction of an addition to the municipal electric plant, a pumping station and installation of motor-driven centrifugal pumping units.

MANDAN, N. D.—The Hughes Electric Company, Bismarck, has applied for permission to erect a transmission line to Hebron and also to build a 38,000-volt line between Beulah and Glen Ullin.

SYKESTON, N. D.—The Ottertail Power Company, Fergus Falls, Minn., plans to erect a transmission line from Washburn, to Sykeston to furnish service in this district.

BEATRICE, NEB.—The Gage County Electric Company, recently incorporated, plans to generate and distribute electricity for light, heat and power purposes. W. C. Black and others are interested in the project.

Southern States

HENDERSONVILLE, N. C. — Preliminary plans are being prepared by the General Gas & Electric Company, 50 Pine Street, New York City, which recently acquired the Blue Ridge Power Company, for the erection of transmission lines for inter-connection with other systems operated by the company, in North Carolina and South Carolina.

TARBORO, N. C.—The Virginia Electric & Power Company, Richmond, has entered into a contract to supply electricity to the Hart and Fountain mills in Tarboro. The power station owned by these mills on Tar River, just outside of the city, has been purchased by the power company, which will improve same and use it for auxiliary purposes in connection with the high-tension lines extending from the power station at Roanoke Rapids.

BEAUFORT, S. C.—The Edisto Public Service Company, Denmark, contemplates the erection of a transmission line here for local service.

COLUMBIA, S. C.—The Columbia Railway & Navigation Company, 1203 Pulaski Street, it is reported, contemplates the construction of a power plant at Monck's Corner, and a dam at Ferguson, etc. E. D. Burchard is district engineer.

BAINBRIDGE, GA.—The Georgia-Florida Power Company plans to erect a number of transmission lines for service in different communities in southwestern Georgia and northern Florida, to cost about $100,000.

BOSTON, GA. — The Valdosta (Ga.) Lighting Company, which has closed a contract with the City Council to furnish electricity in Boston, plans to extend its transmission line here.

HAWKINSVILLE, GA.—The City Council plans to rebuild municipal electric plant and waterworks recently damaged by fire.

PERRY, GA.—The South Georgia Power Company, Albany, which has purchased the municipal electric distribution system, plans to extend its transmission lines here.

WARESBORO, GA.—The Ware County Light & Power Company, Waycross, which has been granted a thirty-year franchise to supply electricity here, plans to extend its transmission line to Waresboro and build a substation.

MIAMI, FLA.—The Royal Palm Ice & Refrigerating Company, 1533 S. W. Third Street, plans to install electric power equipment in its proposed ice-manufacturing and cold storage plant on the Dixie Highway, to cost about $500,000.

MULBERRY, FLA.—The Tampa (Fla.) Electric Company, contemplates the erection of a transmission line for service in this section.

PANAMA CITY, FLA.—The Gulf Power Company, a subsidiary of the Alabama Power Company, Birmingham, Ala., has taken over the power plant of the St. Andrew's Bay Lumber Company and will operate it for central station service. Extensions are contemplated to the plant.

WINTER PARK, FLA.—Bonds to the amount of $50,000 have been voted for extension to the lighting system.

CENTERVILLE, TENN.—The Tennessee Electric Power Company, Chattanooga, which recently acquired the municipal electric plant, contemplates improvements and extensions to the system.

GAINSBORO, TENN. — The Tennessee Electric Power Company, Chattanooga, plans to erect a transmission line from Carthage, to this district, via Elmwood and Granville. Plans are under way by the City Council for the installation of a local distribution system.

GREENVILLE, MISS. — The Greenville Hoop Company is planning to install a new electric power plant in connection with its local plant.

BENTONVILLE, ARK.—The City Council has authorized extensions and improvements in the municipal electric power plant, to cost about $25,000.

VAN BUREN, ARK.—The City Council has authorized the installation of ornamental lamps on East Main and Twelfth Streets.

WELSH, LA. — Improvements to the municipal electric lighting plant are under consideration by the Board of Trustees.

CHEROKEE, OKLA.—The installation of a new engine, pump, etc., in the municipal power plant is under consideration by the City Council.

DOUGLAS, OKLA.—Bonds to the amount of $27,000 have been voted for the installation of a new electric lighting system and the erection of a transmission line to connect the system of the Oklahoma Gas & Electric Company, Oklahoma City, near Covington. H. G. Olmstead, Oklahoma City, is engineer.

AUSTIN, TEX.—Bids will be received by the Board of Trustees of the University of Texas until May 15, for equipment for a power plant at the university, to consist of electric generator with uniflow steam engine, three 500-hp. cross-drum boilers with stokers, coal and ash-handling equipment, feed water heaters; boiler feed pumps, centrifugal pumps, vacuum pumps, etc.

CONROE, TEX. — The Western Public Service Company, Colorado Springs, Col., contemplates erecting a high-tension line from its local plant to Willis. Extensions, to the local plant are contemplated.

GREENVILLE, TEX. — The installation of a substation at the city works shop on St. John's Street is under consideration. H. L. McLow is commissioner.

TYLER, TEX.—Right of way is being secured by the Texas Power & Light Company, Dallas, for an extension of its high-tension line from Tyler to Mineola, where it will connect with the high-tension line of the East Texas Public Service Company that runs from Marshall through Mineola.

Pacific and Mountain States

CHEHALIS, WASH.—The Commissioners of Lewis County have granted the Puget Sound Power & Light Company, Seattle, permission to erect and maintain transmission line on thirty highways in the Meskill, Bunker Creek, Dryad and Doty Districts in the western part of the county and also on several roads in the eastern section.

ELLENSBURG, WASH.—The City Council has decided to contract with the Puget Sound Power & Light Company, Seattle, for electric energy needed in excess of the capacity of the municipal electric plant, rather than to increase the output of the municipal power station.

ASTORIA, ORE.—The City Council is considering a petition for the installation of an improved street-lighting system on Fir Street, between Adams and Monroe Streets.

LOS ANGELES, CAL.—The City Council has adopted ordinances authorizing the installation of ornamental lamps on Montrose Avenue, using thirty-nine pressed steel standards; Melrose Avenue, eighty-one pressed steel standards; Union Avenue, pressed steel standards; Harper Avenue, and Adams Street, both concrete standards; Santa Monica Boulevard, and Hollywood Boulevard, pressed steel standards.

PASADENA, CAL.—A petition for the installation of ornamental lamps on Mar Vista Avenue, between Washington Street and the northern city limits has been granted by the Board of Directors. Concrete posts mounted with single lamps will be used.

SAN DIEGO, CAL.—The Board of City Trustees has authorized the installation of ornamental lamps on E Street, a distance of six blocks.

SANTA BARBARA, CAL. — The City Council is considering the installation of ornamental lamps on Anacapa, Chapala and State Streets, Parker Way, and other thoroughfares.

NAMPA, IDAHO—The City Council is considering the installation of an improved lighting system on portions of Eleventh Avenue, Eighteenth Avenue and Third Street.

PARIS, IDAHO—The Utah Power & Light Company, Salt Lake City, has applied for permission to build a hydro-electric power plant on Paris Creek, near Paris, in the Cache National Forest.

GLENDALE, ARIZ.—The City Council is considering the installation of an ornamental lighting system in the business district.

BOZEMAN, MONT.—The Gallatin Light & Power Company plans to build a local steam-operated power plant to cost about $50,000.

GREAT FALLS, MONT.—The City Council is considering the installation of an ornamental lighting system on Fourth Avenue South, to cost about $23,000.

AURORA, COL. — The Public Service Company of Colorado, Denver, which has recently acquired the distribution systems of the Aurora (Col.) Suburban Light & Power Company and the Brighton (Col.) Ice, Light & Power Company, plans improvements to both systems.

Canada

EDMONTON, ALTA.—The purchase of an additional generating unit, to cost about $275,000, for the municipal electric plant is under consideration by the City Council.

WINDSOR, ONT.—Plans are under way by the Windsor Hydro-Electric System for the construction of a new substation, to cost about $175,000, this summer. The initial installation will consist of two 3,000-kva. transformers; ultimately five 3,000-kva. units will be installed.